HPS
Harvard Project Services LLC

Via U.S. Mail

December 15, 2008

Joseph F. LeMay, P.E.
Remedial Project Manager
US EPA – Region I
1 Congress Street, Suite 1100 (HBO)
Boston, MA 02114-2023

Re: Revised O&M Plan
UniFirst Corporation
Wells G&H Site, Woburn, MA

Dear Mr. LeMay:

Enclosed is a revised Operation and Maintenance Plan for the UniFirst treatment system in Woburn. This revision reflects the changes that resulted from the recent removal of two plumbing components that were previously required for the former UV/Ox unit. The revisions to the drawings and text are relatively minor, but necessary for an accurate O&M Plan. Also, for this revision, I have included into this bound document the equipment manufacturer's manuals that formerly were maintained in a separate volume of Appendix E.

Should you have any questions, please call.

Sincerely,

Timothy M. Cosgrave
Project Manager

TMC:hs
enclosure

cc: Jennifer McWeeney, BWSC, DEP
David Sullivan, TRC
Dawn Kelley, UniFirst

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Operation & Maintenance Plan

UniFirst Treatment System

Wells G & H Site
Woburn, Massachusetts

Revision #5
December 2008

Prepared for:
UniFirst Corporation

Submitted to:
US EPA, Region I

Prepared by:
Harvard Project Services LLC
The Johnson Company

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to provide detailed information regarding the operation and maintenance, as well as monitoring, sampling, analysis, and reporting for the remedial action at the UniFirst site in Woburn, Massachusetts. The site is located at 15 Olympia Avenue in Woburn, where an on-going business; Extra Space Storage, operates. This plan covers the pumping of groundwater from well UC-22 through an on-site treatment system and gravity discharge to a City of Woburn storm sewer, with an ultimate outlet to the Aberjona River. Also included in this Plan is the sampling and analysis of the influent and discharge from the treatment system, and intermediate treatment process locations, and area monitoring wells. This Plan is written, and should be implemented, in conjunction with the Quality Assurance/Quality Control Plan and the Health and Safety Plan for this site, both of which are available as separate documents. This plan supersedes all previous versions of this document.

1.2 OPERATIONS HISTORY

The system treats volatile organic compounds in ground water from well UC-22, located in the northeast corner of the UniFirst property. The original treatment system, which was designed and installed in 1992, consisted of a multi-media filter to remove suspended solids, an ultra-violet/chemical oxidation (UV) unit for destruction of volatile organic compounds and two granular activated carbon tanks in series for polishing prior to discharge of the treated water to the Aberjona River.

The original treatment system was designed to operate at up to 50 gallons per minute to maintain a water level elevation in UC22 of 15 feet NGVD or less. For design purposes, the influent concentration of organic compounds was 10,000 parts per billion. The UV unit was designed with six lamps to properly treat the potential influent concentrations. Routine sampling of the influent water (Port S1) over the last 10 years indicates that the organic chemical concentrations that require treatment are substantially lower than the design parameters and only three UV lamps were been needed at any time. The maximum concentration of tetrachloroethene measured at S1 was 2,900 µg/L (January 13, 1993). Since March 1, 1995, the tetrachloroethene concentration at S1 has not exceeded 2,300 µg/L, or roughly one-half of the design concentration. Average influent concentrations at S1 for the last two years have been less than 500 µg/L.

After evaluating the historical influent concentrations, UniFirst determined that the UV was not the most cost effective or reliable treatment technology and in 2003 installed a new system that would use only carbon for chemical treatment of the groundwater.

With system startup in 1992, a detailed operations and maintenance (O&M) plan was prepared. The O&M plan was revised in March 1994 to reflect operational experience and

minor changes to the system. Water treatment is accomplished through a multi-media filter and three granular activated carbon vessels operating in series. The system has been designed so that three carbon vessels can be operated in any order at any time and the fourth vessel can be serviced.

This version of the O&M plan incorporates all revisions made to the groundwater-monitoring program. The changes to the long-term monitoring program were reviewed and approved by EPA in 1996. No other changes to the long-term monitoring program have been made in this revision.

1.3 GENERAL DESCRIPTION OF FACILITIES

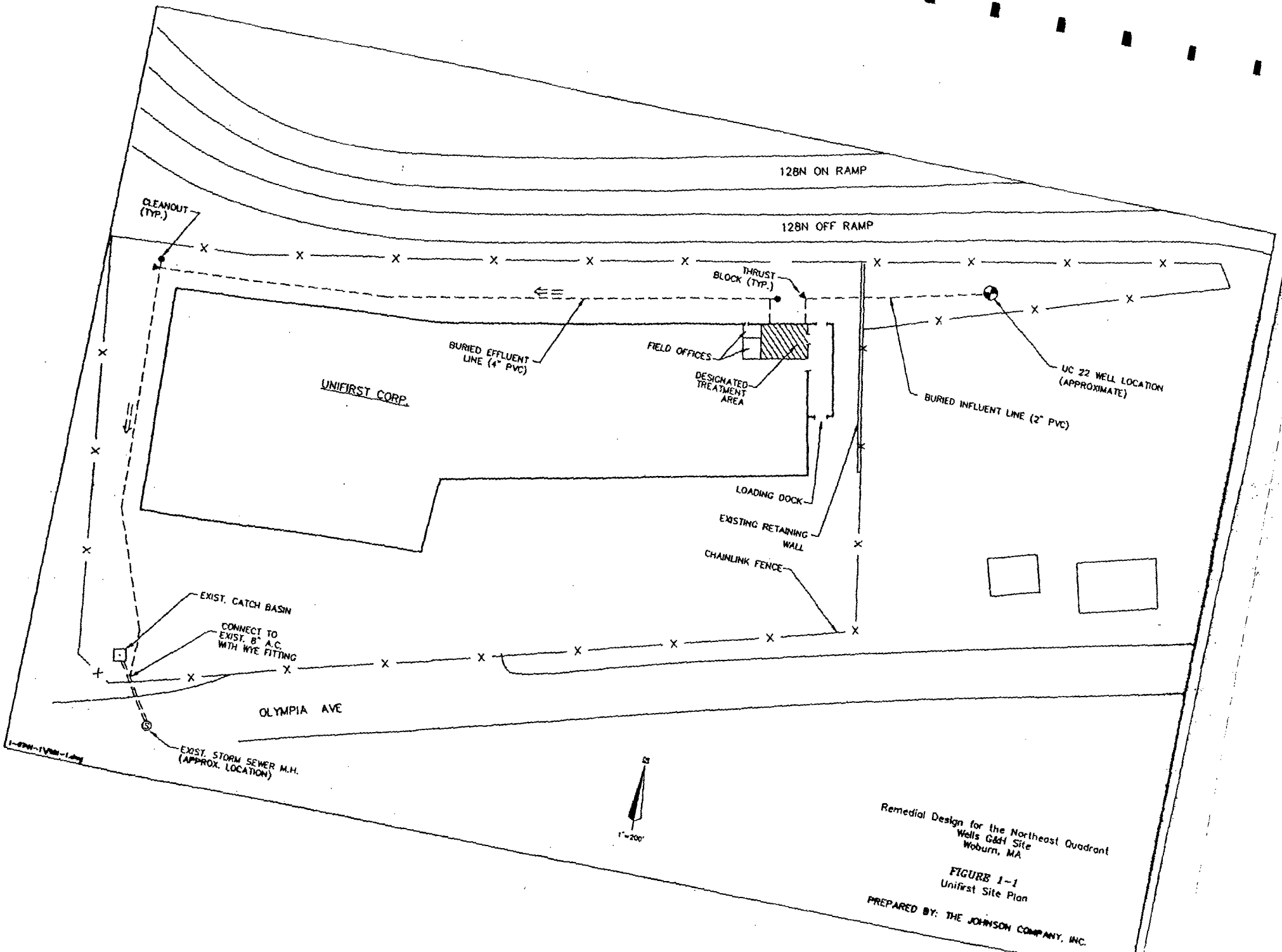
The Treatment system at the UniFirst Plant is designed to treat ground water contaminated with volatile organic compounds pumped from the extraction well UC 22. The treatment system is comprised of a multi-media filter to remove suspended solids, and granular activated carbon tanks to treat volatile organic compounds (VOC). Treated water is discharged to the Aberjona River. A site plan and a schematic of the interior piping are given in Figures 1-1 and 1-2, respectively. A list of the detailed design drawings of the system, and a copy of the Process and Control Diagram are provided in Appendix A. Upon completion of the changes, as-built drawings will replace the design drawings. The system is highly automated with digital flow and pressure sensors that allow for relatively infrequent inspections on a periodic basis and not requiring continuous Operator attendance. The system is designed to monitor its own operating conditions and notify the Operator of any upset conditions that occur between inspection visits. The automated control system allows for remote inquiry by the Operator to obtain a current read-out of operating parameters without physically visiting the site.

1.4 PROJECT ORGANIZATION

Figure 1-3 indicates the organization of the project, and the general relationships between the Owner, the Project Coordinator, and the various contractors associated with the long term operation, maintenance, sampling, and analysis for this groundwater monitoring, extraction and treatment system. The primary contractor that will directly use this Operation and Maintenance Plan is the long-term system operator (the Operator). Primary contacts, and their associated titles, for each company indicated in Figure 1-3 are listed as follows. These contacts are current as of the date of this Plan.

Company/Function	Contact/Title	Telephone
UniFirst Corporation, *Owner*	Jack Badey	978-658-8888
Harvard Project Services LLC, *System Operator*	Tim Cosgrave, Project Manager	978-772-1105 800-391-3036 Pager

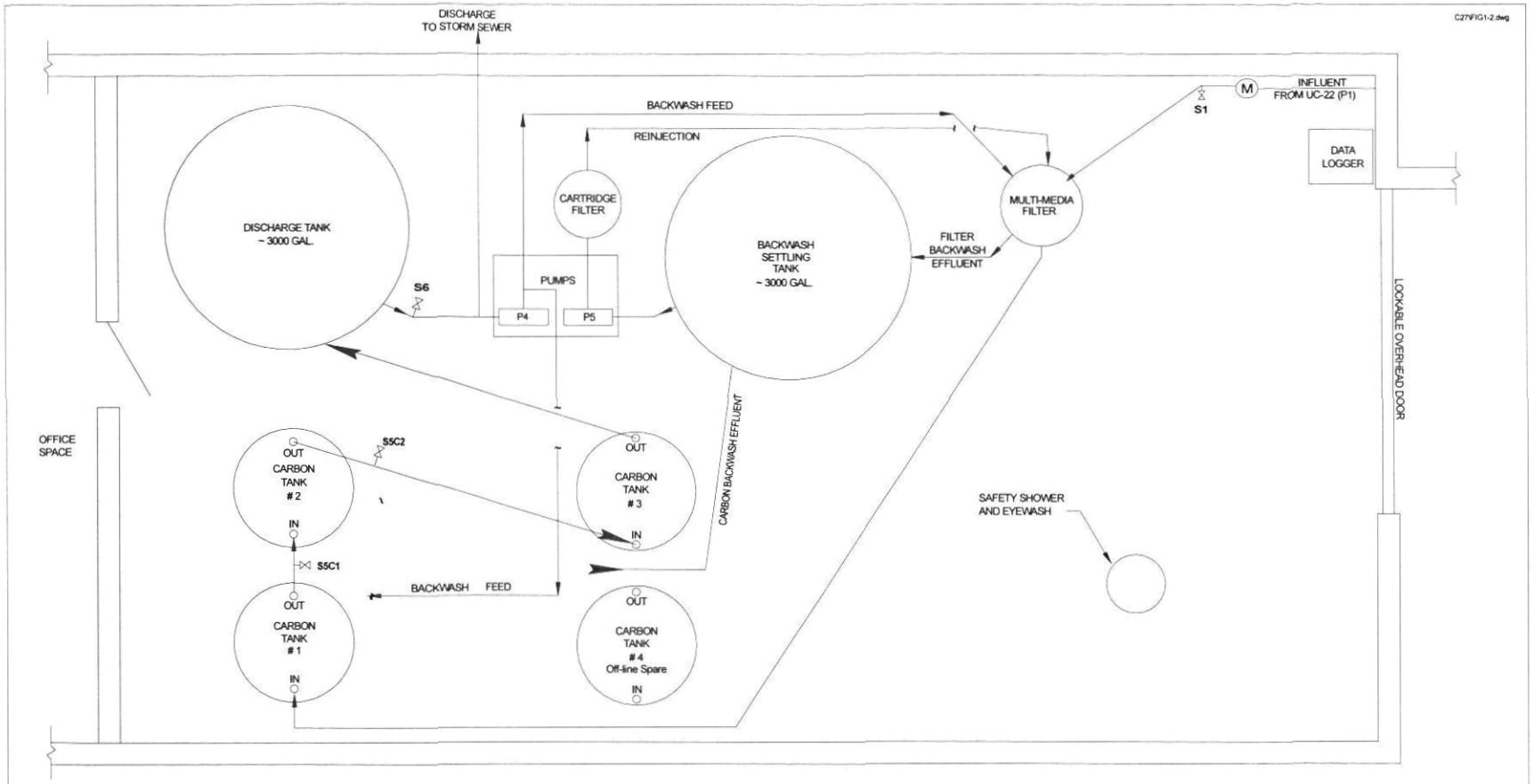
The Johnson Company, Inc., *Original Design Engineer & Hydrogeological Consultant*	Joel Behrsing, Design Engineer Jim Bowes, Control System Specialist Michael Moore, Hydrogeologist	802-229-4600
Project Control Companies, *Project Coordinator*	Jeff Lawson, Project Coordinator	603-966-1600
Environmental Chemistry Consultants, Inc., *QA Officer*	Bruce Wallin, Chemist	253-509-4568
Katahdin Analytical Laboratory	Andrea Colby	207-874-2400
Buckley Brothers Plumbing	Paul Buckley, Plumber	781-322-7509
Heffler Brothers Electrical	Kevin Heffler	781-273-5933



Remedial Design for the Northeast Quadrant
Wells G&H Site
Woburn, MA

FIGURE 1-1
Unifirst Site Plan

PREPARED BY: THE JOHNSON COMPANY, INC.


C27\FIG1-2.dwg
DISCHARGE
TO STORM SEWER
INFLUENT
FROM UC-22 (P1)
M
S1
BACKWASH FEED
REINJECTION
DATA
LOGGER
CARTRIDGE
FILTER
MULTI-MEDIA
FILTER
DISCHARGE TANK
~ 3000 GAL.
BACKWASH
SETTLING
TANK
~ 3000 GAL.
FILTER
BACKWASH
EFFLUENT
PUMPS
S6
P4
P5
LOCKABLE OVERHEAD DOOR
OFFICE
SPACE
OUT
CARBON
TANK
2
IN
S5C2
OUT
CARBON
TANK
3
IN
CARBON BACKWASH EFFLUENT
SAFETY SHOWER
AND EYEWASH
S5C1
BACKWASH FEED
OUT
CARBON
TANK
1
IN
OUT
CARBON
TANK
4
Off-line Spare
IN
LEGEND
S5 SAMPLING PORT
M FLOW METER
Revised: 09/09/02 TMC
Revised: 3/17/94 TJK
Revised: 12/14/92 TJK
Drawn: 9/10/92 TJK
UniFirst Treatment System
Wells G&H Site
Woburn, MA
FIGURE 1-2
Unifirst Treatment System Schematic
PREPARED BY: Harvard Project Services LLC
Prime Engineering
The Johnson Company

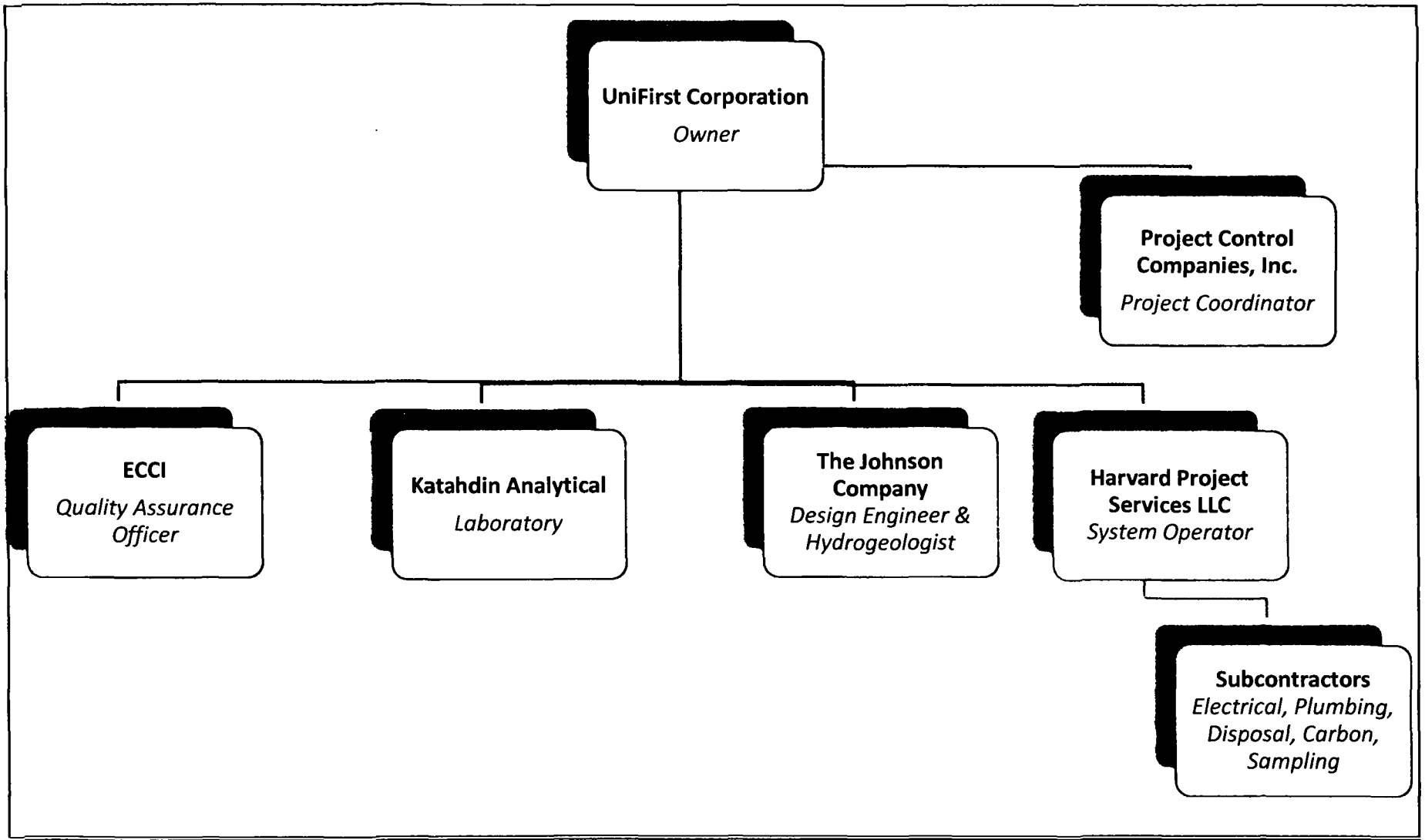


Figure 1-3
Project Organization
UniFirst Treatment System
Woburn, Massachusetts

2 DESCRIPTION OF SYSTEM COMPONENTS

2.1 WELL PUMP

The water is pumped from well UC 22, which is located approximately 150 feet east of the UniFirst building. The well is cased to a depth of about 12 feet with 8-inch steel well casing and has a total depth of 188 feet. The pump is suspended on 2-inch diameter plastic pipe to a depth of 178 feet. The pipe exits the well casing at a depth of approximately four feet below ground surface through a pitless adapter to the buried 2-inch PVC influent pipe.

The current well pump has a 3 hp, three-phase motor, and is manufactured by Grundfos (Model No. 40S30-9). A new pump was installed in July 2007.

2.2 INFLUENT LINE

The 2-inch PVC SDR21 influent line is buried at a nominal depth of four feet below ground surface. In the same trench, there are three conduits for conveying electrical lines and housing the sensor cable. One of the conduits is a 2-inch conduit for the electrical lines to the pump motor. The other two conduits are 1.5-inch conduit: one for the sensor cable and the other held in reserve for future use.

The influent pipe enters the building under the footing of the frost wall and up through the floor slab in the treatment room. A diaphragm check valve at the system inlet eliminates pressure surges through the system from pump start-up. Beyond this point, the flow passes through a digital flow sensor that is connected to a data logger (See Section 2.7: Control Functions) and an electrically actuated ball valve used to adjust the flow from the pump to maintain the drawdown of the pumping well.

2.3 MULTI MEDIA FILTER

The first level of treatment the system flow will pass through is a multimedia filter. This filter is manufactured by Bruner Corporation (Model No. ML300). The operating pressures for this filter are:

Influent Pressure:	40-100 psi
Discharge Pressure:	44 psi
Maximum Pressure Differential	18 psi

Backwashing is required when the pressure differential across the multi-media filter exceeds 18 psi. Pressure in the multi-media filter is monitored with pressure gauges on the inlet and outlet. Additionally, a pressure transducer, located at the same position as sampling port S1, is connected to the datalogger to track the influent pressure at the multi-media filter. The

filter may need to be backwashed prior to reaching the maximum differential to maintain flow (see Section 3.4.1: Multi-media Filter).

2.4 CARBON TANKS

The effluent from the multi-media filter flows through three granular activated carbon tanks in series. The adsorption life span of each carbon tank is dependent on the concentration in the influent water.

There are a total of four carbon tanks. In 2007, four new fiberglass tanks were installed at the facility. Each tank has the capacity to hold approximately 1,500 pounds of carbon, but generally hold 1,000 pounds of carbon to optimize flow and backwash operations. These tanks have an inlet and air vent on the top of the tank and an outlet on the bottom. The tanks have a 20-inch bolted cover on the top for access. All tanks have valves at the bottom. Process flow through all tanks is downward. The tanks are designed to be backwashed by reversing flow.

The carbon tanks are connected with a system of 2-inch flexible hoses. There are two manifolds which to connect the tanks to system influent/effluent and backwash influent/effluent flows, as needed. The tanks operate in series by connecting the flexible hoses in the appropriate positions.

2.5 DISCHARGE COLLECTION TANK

The discharge collection tank is a 3,000-gallon high-density polyethylene (HDPE) tank that receives effluent from the carbon tanks. The effluent piping is arranged so that approximately 1,000 gallons will be retained in the tank at all times to provide some equalization prior to the effluent sampling point, and to provide a volume of clean water for back washing the multi-media filter, or the carbon tanks, as necessary.

2.6 DISCHARGE LINE

The gravity discharge line exits the building through the treatment room floor slab, and under the concrete footing.

The discharge line is a buried 4-inch PVC SDR35 pipe that runs along the North and West sides of the building where it connects to a storm sewer immediately downstream of a catch basin on the UniFirst property near Olympia Avenue (see Figure 1-1).

Clean outs are installed at the bends in the line immediately outside the building and at the northwest corner of the building, and are set flush with the existing pavement. The riser is accessed through the threaded caps on the top of the clean-outs and is protected with a cast iron valve box top section. These clean-outs are provided for cleaning the discharge line if needed. It is not anticipated that this will be required very often, if at all.

2.7 CONTROL FUNCTIONS

Automatic monitoring of the treatment system is facilitated using a data logger and various sensors and control valves. The data logger, which is the central control unit for the system, is a Model CR10 manufactured by Campbell Scientific, Inc., Logan Utah and consists of a programmable module which has been programmed to provide sensor measurements, timekeeping, communication, data reduction, data storage, and control functions. Control functions consist of both routine operational and alarm activated functions as described below. These functions are summarized in Table 2-1. An overview of the monitoring and control system is given in Appendix B along with a copy of the program instructions.

The alarm activated control functions consist of two modes: 1) "critical alarm" detection, which if indicated, drops power to the well pump in UC22 (Pump P1) and results in a system shutdown; and 2) "non-critical" alarm detections, which if indicated initiates a telephone call to the operator's pager, but does not result in a system shutdown. The CR10 is programmed with an alarm detection capability of one-minute resolution.

The control functions of the data logger are triggered by either measurement data recorded by the data logger, or by a switch monitoring system routed through the data logger. Various components of the UniFirst treatment system are monitored by connecting the data logger to a Model 910 Annunciator (McMaster Carr). The 910 Annunciator contains a central relay panel composed of 10 independent switches. Relays and/or contacts from the individual alarm modes are connected to the main circuit of the 910 Annunciator. The annunciator is used to monitor components considered critical functions.

The annunciator provides a link between on-site conditions and the data logger. The link is provided by a direct wire connection from the data logger control port channels (channels 4 and 5) and a relay switch from the main circuit board of the annunciator. If an alarm is indicated from any of the external relays or contacts connected to the annunciator, the data logger will acknowledge, and respond accordingly. Additional details on data collection and control and alarm functions are provided in Appendix B.

2.7.1 Routine Control Functions

Automatic Valve Operation: The primary routine control function of the data logger consists of regulating the treatment system flow to maintain a steady drawdown level in well UC22. The flow is regulated by an automatic valve: Model EA20 electric actuator and ball valve (auto-control valve) manufactured by George Fischer Signet, Inc., Tustin, California. By maintaining a steady drawdown level in the well, a steady zone of capture is maintained. The valve is controlled by the CR10 interfaced with a SDM A04 4-channel analog output device (SDM A04). The SDM A04 is manufactured by Campbell Scientific, and serves as the power input device that controls the range of operation of the valve.

Upon initial system start-up and during subsequent start-ups, the auto-control valve (B1) is controlled by input from the flow sensor (Data Industrial Model # 228 B). The flow signal monitored by the data logger is proportionalized to output an analog signal to the auto-control valve. The anticipated range of operation of the auto-control valve is maintained by the signal from the flow monitor until the drawdown elevation in UC22 reaches 15 feet NGVD, the "trigger" elevation. When the "trigger elevation" is indicated, the auto-control valve control becomes controlled by readings from the pressure transducer in UC22. The purpose of this alternate control arrangement is to prevent the high water level readings during initial drawdown (start-up) from signaling the auto control valve to open fully, potentially allowing unacceptably high flow rates through the treatment system.

The CR10 records the drawdown level in UC22 through a Druck (model # PDCR 940) pressure transducer. An offset has been applied to the Druck signal, which converts it to an actual elevation reading referenced to a benchmark elevation at the top of casing of UC22. Once the Druck signal has been recorded and processed, the CR10 initiates an output signal via the SDM A04. It is this output signal that controls the valve.

The battery whose voltage is being monitored by the data logger is the primary power source for the data logger. This battery is continually being re-charged by an AC transformer unless there is a power outage at the site in which case, the battery voltage will slowly be depleted.

Data logger panel temperature is monitored to insure that the data logger manufacturer's recommended operational temperature range is not exceeded.

Daily data summary storage is provided so that average and total readings for each day of operation can be retrieved, downloaded and reviewed on a periodic basis. The methods for data management are described in detail in Section 3.2.

2.7.2 Critical Alarm Control Functions

The procedure that the CR10 implements after detecting a critical alarm is to first drop power to Pump P1 in UC22, then initiate a telephone call to the system operator's pager, and thirdly, record the date, time, and general source of the alarm. The alarms are indicated either from sensors wired directly to the data logger, or from a central annunciator panel connected to external relays from various components of the treatment system. One of the sensors that monitors for an alarm condition is the Data Industrial 228-B flow sensor. The flow sensor is monitored through a pulse count channel of the CR10.

The external circuitry (*i.e.*, electrode/relays) is monitored through a control port in the CR10 data logger that is wired to the main circuit board of the 910 Annunciator, which allows external identification of the source of an alarm by an illuminated LED.

Low Flow measurement. This alarm is tripped when less than 5 gpm is indicated by the flow sensor. There is a one-minute delay prior to shutting off Pump P1 to allow verification of the no flow condition (*i.e.*, the sensor is re-read).

High-level backwash tank electrodes. A critical alarm of high water in the backwash tank will be indicated by a closure signal from electrodes mounted 10 feet above tank bottom. This alarm is very similar to the floor sump alarm, in that normal operation will be indicated by an open circuit in the main indicator panel. The CR10 will respond in the same manner when this alarm is tripped.

Pressure relief flow switch and floor sump electrodes. These two alarms are actually critical alarms, but since they will operate independently of the data logger, the only way to notify the operator of the event and to record when they have been activated is to connect a parallel wire from a relay to Control Port in the data logger to monitor if the relay has been tripped due to either of these events. The response by the data logger will be the same as if a non-critical alarm had occurred, *i.e.,* initiation of an alarm telephone call and storing of the date, time and general source of the alarm; the only difference is that the system will have been shut down already automatically as described below.

A ¾-inch pressure relief valve (100 psi) is located upstream of the auto-control valve. A flow switch located in the ¾-inch pressure relief discharge pipe will also shut down the well pump by direct wiring to the relay that controls Pump P1.

There are electrodes installed in the floor sump in the treatment room at an elevation 6 inches below the finished floor elevation. If a leak occurs that results in the floor sump filling up, the electrode contact is closed and the signal will drop power to Pump P1 via the control relay.

The relays from the floor sump electrodes and pressure relief flow switch are wired to the Control Port that monitors the non-critical alarm modes. Therefore, when these mechanisms are tripped, the event will be recorded in the data logger, and notification made in the manner described in Section 2.7.3. A review of the system operating parameters from a modem link will indicate if the pump was dropped or the alarm was non-critical. The procedure for conducting this review is provided in Appendix C.

2.7.3 Non-Critical Alarm Functions.

A non-critical alarm is of a magnitude that does not warrant a system shutdown, but requires notification of what the condition is and when it has occurred so that when the Operator arrives, the condition can be remedied. Detection of non-critical alarms by the data logger will be necessary to provide time keeping of when this type of alarm has occurred. The response by the data logger to a non-critical alarm is to implement a programmed routine that

includes initiation of a telephone call, and the storing of the date, time and general source of the alarm.

Low temperature in treatment room. The CR10 monitors the temperature in the treatment room via a temperature probe. If the room temperature should fall below the set point, indicating the potential for freezing problems in the treatment room the data logger will implement the non-critical alarm response routine. The set point for the low treatment room temperature alarm is provided in Table 2-1.

Table 2-1 Data Logger Measurement & Control Functions

Routine Functions		
Function	*Device*	*Normal Operating Condition*
Flow control	Auto Control Valve (B1)	Approx 2500mV signal from data logger
Pump control	Pump relay	
Measure carbon tank pressures	Pressure transducers at carbon tanks	7 to 15 psig
Measure influent pressure at multi-media filter (MMF)	Pressure transducer at MMF	40 to 100 psig
Measure drawdown in UC22	Pressure transducer in UC22	15 ft NGVD
Measure system flow	Flow Sensor/Monitor	40 to 50 gpm
Measure battery voltage	Data logger	9.6 to 13.4 volts DC
Monitor room temperature	Temperature sensor	50 to 80 °F
Store select data	Data logger	

Critical Alarm Functions		
Function	*Device*	*Set Point*
Low Influent Flow	Flow sensor/monitor	≤5 gpm
High water in Backwash tank	Level electrode in tank	10 feet above tank bottom
Response: 1. Pulse relay to shut down P1 2. Initiate pager call, send code: 222222 for low flow, 444444 for high backwash tank 3. Record date, time source of alarm		

Non- Critical Alarm Functions		
Function	*Device*	*Set Point*
Pressure Relief Valve opens[1]	Flow switch at PRV	>100 psig
High water in floor sump[1]	Level electrode in sump	6 inches below floor elevation
Low treatment room temperature	Temperature sensor	≤35 °F
Water level in UC22	Pressure transducer in UC22	>25 ft NGVD for >60 mins
Response: 1. Initiate pager call, send code 666666 (If water level >25 feet, send 777777) 2. Record date, time source of alarm		

[1] Pump P1 (UC22) already shut down by separate circuit.

3 SYSTEM START-UP, OPERATION & TROUBLE SHOOTING

3.1 START-UP REQUIREMENTS

The treatment system was designed and constructed to allow for easy start-ups with minimal operator involvement. The initial signal sent to the auto control valve from the data logger sets it at 100 % open. Once flow begins, the valve will close to about 50% at 50 gpm. Treatment is provided by a series of carbon tanks. The flow from the last carbon tank passes through an elevated section of pipe prior to discharging into the discharge tank. This prevents any draining or siphoning of the carbon tanks and other equipment during shutdown periods, making refilling or venting generally unnecessary. There is no need to close any valves or perform any other actions upon shutdown.

A general start-up procedure is provided below. The procedure is for normal start-ups and shutdowns and for restart after a short shutdown. To restart the system after an extended shutdown it is recommended that the Operator consult with the Design Engineer. Although the procedure is expected to be the same, there may be special conditions resulting from the cause of the extended shutdown that may need to be considered. Similarly, if an extended shut down is anticipated, the Operator should consult with the Design Engineer, to determine what special precautions (if any) should be taken. These actions are likely to be specific to the nature and duration of the extended shutdown.

3.1.1 Start-up Procedures

I. Normal Operating Valve Configuration

1) Using the Initial and Normal Operating Valve Position Schedule located at the end of Appendix D, verify that the system's valves are configured for normal operations. The data logger has a battery back-up that will provide the signal to set the auto control valve 100% open in the absence of electrical power. View the indicator on the auto control valve to verify it is 100% open.

II. Normal Electrical Systems Configuration

1) All the circuit breakers in Panel PP1 must be in the "on" position with the exception of breakers #15, 19 [and UV breakers] which are spares and should be kept "off." The circuits controlled by the various breakers are noted on the inside of the panel door.

2) The starters for the well pump (P1) must be in the "auto" position. The backwash pump (P4) and the reinject pump (P5) must be in the "auto" position to use the hand held start switches at the pumps. The pump (P5) circuit must be reset at the starter after each automatic shutdown triggered by the low level electrodes in the backwash settling tank.

III. Initial Filling and Venting

1) There is no requirement to fill and/or vent treatment system piping and equipment during normal start-ups.

2) Replacement of spent carbon will require draining water from the unit and filling it with new carbon. A procedure for carbon tank replacement is provided in Section 3.6.

IV. Normal Start-up

1) Reset the pump starter circuit and energize well pump P1 by pressing the start button on the pump motor starter (the indicator must be in the "auto" position). Flow and pressure within the treatment system will occur almost immediately. A normal inlet pressure of 40 to 110 psi should be observed on the inlet pressure gauge. The flow monitor should indicate a flow rate between 30 and 50 gpm.

2) Enable the alarm detection modes of the data logger.

V. Start-up After Critical Alarm Condition.

1) Disable the alarm detection modes of the data logger.

2) Acknowledge and reset the Annunciator noting which indicator light is lit.

3) Determine and correct the cause of the critical alarm.

4) Reset the starter control circuit for the well pump (P1) motor by pushing the pump control reset button.

5) Follow the procedures for normal start-up in Part IV above.

VI. Normal Shutdown Procedures

1) Prior to initiating a planned shutdown disable the alarm detection modes of the data logger.

2) Shutdown the well pump (P1) by turning the indicator switch on the motor starter to the "off" position.

3.2 OVERALL SYSTEM MONITORING

Each inspection tour will include checking the system from the pumping well to the discharge point for upset conditions, and operational or maintenance requirements. During each inspection tour an inspection log will be filled out detailing the field observations including any problems that need to be addressed and what actions were taken. A field

operation log form is included in Appendix C. Experience has found that the weekly inspection tour frequency is adequate.

In addition to the scheduled facility inspections, the system is monitored from a remote location through the data logger on the site, via modem at a remote facility. Data such as flow rates, pressures, and drawdown will be reviewed. Following is a summary of the information that the data logger will be reading:

- Elapsed day (Julian day)
- Water level elevation in UC22 (datum is a bench-mark in a notch on top of the 1-inch polyethylene water level monitoring pipe which is 85.525 feet NGVD).
- Volts (Data logger battery pack) which should be greater than 9.6.
- Panel Temperature (acceptable range for the data logger is 13°F to 122°F)
- Carbon pressure at the inlet to the carbon tanks (max design pressure is 12 psi)
- Carbon pressure between the primary and secondary carbon tanks
- Carbon pressure between the secondary and tertiary carbon tanks
- Pressure at the inlet to the multi-media filter
- Flow rate in gpm
- Alarm call: the cumulative number of alarm call-out events to date.
- Annunciator: a reading of 0 indicates that the alarm circuits are all open, a reading of 8 or 16 indicates that one of the alarm circuits are closed.
- mV- Output signal: signal to auto control valve. Range is 0 mV (closed) to 5000 mV (fully open).
- Treatment room temperature

The data logger has a scan rate of 60 seconds on all parameters. The instantaneous readings can be read at the site by calling up the individual parameters via the key pad at the data logger, or from a remote computer via a modem and the telephone line.

The 60 second readings are processed at the top of each hour and stored as follows:

Average water level in UC 22
Average carbon pressure upstream of Carbon #1
Average carbon pressure between Carbon #1 and Carbon #2
Average carbon pressure between Carbon #2 and Carbon #3
Average multi-media filter influent pressure
Total gallons
Instantaneous battery pack volts
Instantaneous panel temperature

Every 24 hours (at 12:00 AM) the data is further processed and stored as follows:

- Year

- Calendar day
- Time of data processing
- Average water level in UC 22
- Maximum and minimum water level in UC 22, and associated times.
- Average carbon pressure upstream of Carbon #1
- Average carbon pressure between Primary and Secondary Carbon
- Average carbon pressure between Secondary & Tertiary Carbon
- Average multi-media filter influent pressure
- Maximum and minimum carbon pressure, and associated times.
- Total gallons
- Average Flow Rate in GPM
- Maximum and minimum flow rates, and associated times.
- Average battery pack volts
- Average panel temperature.

The treatment room temperature is not stored by the data logger. The data logger continually monitors the temperature to compare to the low room temperature alarm set point.

The hourly and daily summary data will be retrieved from the data logger via modem over a telephone line.

The calibration of the system sensors is to be verified on a quarterly basis. The Quarterly Sensor Calibration checklist for performing this verification is included in Appendix C.

3.3 WELL PUMP

The well pump is designed to operate continuously without maintenance requirements and should provide years of unattended operation. The current well pump was installed in July 2007. New plastic well piping was installed in 2006. Following are potential well pump failure scenarios and the appropriate Operator responses.

Well Pump Failure

Nature of Failure: Failure or significantly reduced performance of the well pump would result in a complete loss of flow and pressure to the treatment system. This condition can result from an area power failure, pump motor burn-out, or a shut-down signal from one of the critical alarm functions. The flow sensor will read no flow, the well pressure transducer will show a rapid recovery in UC22, and the in-line Druck will show a loss of pressure. All of these sensor outputs will cause the data logger to interrupt power to the pump and notify the operator of an upset condition.

Operator Response: The operator should first determine if the failure is a result of an area or building power failure or specific to the treatment system. If power failure is regional, the operator should contact NStar to report the power outage. If the power failure is localized to the building or the treatment system, the operator should contact

a licensed electrician to diagnose and correct the problem. Follow-up phone calls should also be made to the Design Engineer and/or the Project Coordinator.

If the failure is the result of the well pump or pump motor failing, the operator should contact a licensed well pump installer to pull and replace the pump with an equal unit. Follow-up phone calls should also be made to the Design Engineer and/or the Project Coordinator.

3.4 BACKWASH PROCEDURES

Backwash of the multi-media filter and the activated carbon tanks will be required on a periodic basis to remove solids built up that create excessive pressure drop across the filters. The decision to backwash a particular filter will be made based on the pressure drop across the filter as recorded during the periodic inspections or via remote monitoring. A description of the backwash procedures is provided in the following sections. References are made to various valves and pumps which are described in the valve and equipment schedule in Appendix D. Valve and pump designations indicated in the schedule are shown in their actual physical location on the drawings listed in Appendix A, and in their functional location on the Process and Control Diagram provided in Appendix A.

3.4.1 Multi-media Filter

Backwash of the multi-media filter must be initiated if the pressure differential between the influent and discharge lines exceeds 18 psi. The filter may need to be backwashed before the maximum allowable pressure drop is achieved to maintain the desired draw-down level in the extraction well. During backwash the filter is taken off-line with the flow being bypassed or alternatively the extraction and treatment system is shut down for the duration of the backwash (approximately 10-20 minutes). The water used for the backwash feed comes from the system discharge tank. This water has been treated through the system and is stored in the tank prior to discharge. An adequate volume of water must be accumulated in the discharge tank for the backwash by closing valve B16 for a period before shutting down the system. The multi-media filter automatically restricts backwash flow to approximately 75 gpm, therefore approximately 1,500 gallons; or, at a 330 gallons per foot of water depth, 4.5 feet of water depth is required for a 20 minute backwash. The depth of water in the discharge tank should not be less than 1 foot at any time during backwashing events to prevent damage to the backwash pump (P4). The backwash discharge water flows to the backwash tank where suspended solids are allowed to settle out prior to reinjection of the supernatant.

Instructions for loading and unloading the filter can be found in the manufacturer's literature in Appendix E.

The following procedure should be followed when backwashing the multi-media filter.

I. Bypass the multi media filter

1) Observe and record current flow rate from flow monitor.
2) Open bypass valve number G2.
3) Close influent valve number B2.
4) Close effluent valve number B4.
5) Adjust valve number G2 to maintain the initial flow rate observed.

II. Set valves at multi media filter for backwash
1) Close influent valve number Fl.
2) Open backwash discharge valve number F3.

III. Set valves at pump P4 for backwash
1) Open valve number B20 on pump discharge.
2) Close system discharge valve number B16.
3) Open suction valves numbers B15 and B17.
4) Check that valve number G3 is closed.

IV. Backwash the multi media filter
1) Record initial water level in backwash settling tank via the tank site tube.
2) Start pump P4 and record discharge pressure (normal discharge pressure should be approximately 40 psig).
3) Run pump P4 for 15 to 20 minutes or until backwash effluent is clear.
4) Stop pump P4 and record final level in backwash settling tank.

V. Reset valves at pump P4
1) Close valve number B20 on pump discharge.
2) Open system discharge valves number B16.
3) Close suction valves number Bl5 and B17.

VI. Set multi media filter valves for operation
1) Close backwash discharge valves number F3.
2) Open influent valve number Fl.

VII. Direct flow through multi media filter
1) Open effluent valve number B4.
2) Open influent valve number B2.
3) Close bypass valve G2.
4) Record pressure differential.

3.4.2 Carbon Tanks

Each of the four carbon tanks may be operated and/or backwashed independently. The tanks are to be operated in a series of three. When operated in series, the flow is redirected to the next tank via a flexible hose.

Backwash of each carbon tank should be initiated if the influent pressure line exceeds 12 psi. When a new tank is initially placed on line, the carbon manufacturer recommends initial backwashing to remove fines and properly prepare the carbon bed for use.

A newly-filled tank can be backwashed while the System is operating. The water used for the backwash feed comes from the system discharge tank. This water has been treated through the system and is stored in the tank prior to discharge. An adequate volume of water must be accumulated in the discharge tank for the backwash by closing valve B16 for a period prior to shutting down the system. At a carbon backwash flow rate of approximately 50 gpm, the required volume of water is approximately 1,000 gallons per carbon tank; or, at a 330 gallons per foot of water depth, 3.5 feet of minimum water depth is required for a 20 minute backwash. The depth of water in the discharge tank should not be less than 1 foot at any time during backwashing events to prevent damage to the backwash pump. The backwash discharge water is returned to the backwash settling tank where suspended solids are allowed to settle out prior to reinjection of the supernatant back into the treatment system. Each backwash event should be recorded on the Treatment System Operation Log (Appendix C).

A detailed description of carbon tank backwash procedures is provided below. These procedures assume that a given carbon tank is being backwashed while flow to the other three tanks is maintained. In the example, the valve settings for backwash of any carbon tank are described.

I. Configure the tank
   1) Close influent valve leading to the top of the tank.
   2) Close effluent valve leading from the bottom of the tank.
   3) Install a flexible hose from the backwash influent to the bottom of the tank.
   4) Install a flexible hose from the backwash effluent to the top of the tank.
   5) Open influent valve leading to the top of the tank.
   6) Open effluent valve leading from the bottom of the tank.

II. Set valves for backwash
   1) Open valve number B25 on backwash pump (P4) discharge.
   2) Open valve number G3 a half of a turn.
   3) Close system discharge valve number B16.
   4) Open suction valves numbers B15 and B17.
   5) Check that valve number B20 is closed.
   6) Open backwash influent and effluent valves B23 and B24

III Backwash the carbon tank
   1) Record initial level in backwash settling tank via the adjacent sight tube.
   2) Start Pump P4 and observe flow rate and record initial time.
   3) Adjust valve number G3 for a backwash flow rate of approximately 40 gpm. Under no circumstances should the backwash flow rate exceed 50 gpm.
   4) Run pump P4 for 10 to 15 minutes or until backwash effluent is clear. Some

carbon fines may be present in the effluent at the end of the backwash cycle.

5) Stop pump P4 and record final level in backwash settling tank and the time.

IV. Reset valves at pump P4

1) Close valves number B25 and G3 on pump P4 discharge.
2) Open system discharge valve number Bl6.
3) Close suction valves number B15 and B17.

V. Redirect flow through carbon tanks.

1) Close backwash influent and effluent valves B23 and B24.
2) Close influent valve leading to the top of the tank.
3) Close effluent valve leading from the bottom of the tank.
4) If the tank was in the process flow, reconfigure flexible hoses for process order.
5) If the tank was in the process flow, record inlet pressure.

3.5 REINJECTION PROCEDURES

The backwash tank accumulates water from backwash of the multi-media filter and the carbon tanks, water from the sump pump and from purge water transfer. Reinjection of the backwash water should be initiated only after adequate time has passed for all of the suspended solids to settle to the bottom of the tank. A sample of the water should be collected from the port on the reinjection pump (P5) suction line in a clear glass container and viewed for clarity to assure adequate settlement has occurred. Reinjection should be accomplished after every carbon and filter backwash and before the next backwash event to not re-suspend the previously settled solids, and to maintain available volume in the tank for future requirements. The supernatant is drawn from the backwash settling tank through a strainer, pumped through a cartridge filter and reinjected into the front-end of the treatment system upstream of the multi media filter. The backwash water is reinjected at approximately 3-5 gallons per minute using Pump P5. The pump is controlled by a pair of low level electrodes that automatically turn the reinjection pump off once the backwash settling tank water elevation is lowered to a pre-set low level. The pump is also controlled by a differential pressure switch that monitors the pressure drop across the cartridge filter. The pump will be automatically shutdown when the differential pressure across the cartridge filter exceeds 15 psi. The filter element should then be cleaned by rinsing, collecting rinsate in a drum designated for this purpose. High-level electrodes in the backwash tank will shut the entire system down and notify the operator of high water level in the backwash tank. (See Appendix A - Process and Control Diagram)

The following procedure should be followed to reinject settled backwash water.

I. Check clarity of water, clean suction strainer and set valves at reinjection pump P5.
   1) Close suction valve B19 to isolate the strainer. Remove and clean the sediment strainer on the Pump P5 suction pipe as necessary.
   2) Replace sediment strainer and open suction valve B19.
   3) Collect a sample in a glass container from the port on the pump suction line. The sample should be free of solids that will settle.
   4) Check that Pump P5 discharge valves B22, B27 and B27A are open.

   NEVER REINJECT IF MULTI-MEDIA FILTER IS BEING BYPASSED.

II. Reinject the settled backwash water
   1) Reset the pump P5 circuit by pressing the reset button on the pump starter located next the electric panel PP1.
   2) Start pump P5 and record the time, the pressure on either side of the filter and injection pressure on the operation log.

Pump P5 will automatically stop when the water level in the backwash tank is approximately 2 feet from the bottom. During the next site visit after completion of the reinjection, close all valves at the cartridge filter (B19, B22, B27 and B27A). Pump P5 will

also stop automatically if the differential pressure across the filter exceeds 15 psi. This indicates the filter cartridge needs to be cleaned or replaced. (Refer to the manufacturer's installation and operation manual in Volume I of Appendix E.)

3.6 CARBON MEDIA REPLACEMENT

On a periodic basis, the carbon in the primary tank will be exhausted and the media will need to be replaced. The replacement frequency is directly dependent on flow rate and influent concentrations. The series operation of the carbon tanks will theoretically allow the carbon in the first tank to approach saturation without jeopardizing the final effluent discharge limits. The decision to replace the primary tank media will be based on the chemical analyses of water samples taken before and after the primary carbon tank (S5C1 and S5C2, respectively). The decision to change the media in the primary carbon tank will be made by the System Operator. The decision may be reviewed by the Design Engineer or the Project Coordinator. The process will generally involve changing hose connection positions so that the secondary tank becomes the primary tank and the tertiary tank becomes the secondary tank. The new tertiary tank will be the most-recently serviced carbon tank. The new carbon media will be installed in place of the spent media and the tank will become the off-line spare tank ready to be brought on line when the primary tank is exhausted. The spent carbon will be managed as hazardous waste in accordance with the requirements for a Small Quantity Generator.

In anticipation of changing out the carbon media, the Operator will order and coordinate replacement of the carbon media. Approximately 24 hours or more in advance of the carbon replacement date the Operator will need to reconfigure the tanks directing all flow to the new tank order. The spent carbon tank must then be drained to the floor sump. The sump pump then pumps the water into the backwash settling tank for future reinjection into the treatment system. The spent carbon can then be removed using a vacuum system and packaged for shipping to an appropriate facility. The fresh carbon will then be loaded into the empty tank, saturated and backwashed to prepare it for use. The actual removal and replacement of the carbon media will be performed by the system operator or a contractor specifically engaged to perform those activities.

The following describes the general process for changing flow through the system and preparing a spent carbon tank for servicing. Refer to Table 3-1 for the valve settings for the current process flow and to isolate the offline tank.

I. Shut down the System.
II. Reconfigure the flexible hoses for flow through the tanks in the new process order. Install sample ports S5C1 and S5C2 in the appropriate lines. S5C1 should be installed in the discharge from the primary tank and S5C2 in the discharge from the secondary tank.
III. Restart the System.
VI. Service the spent carbon
    1) Drain spent carbon tank to floor sump.

2) Once the spent tank has drained, coordinate with the contractor to remove the spent carbon and replace it with fresh media.
3) See the equipment manufacturer's specifications in Appendix E for correct procedures for tightening the flange cover.

VII. Bring carbon tank with fresh media "on-line"

1) Slowly fill (approximately 5 gpm) the unit with municipal water through the manway. Wait at least 24 hours for the carbon to wet and air to be vented.
2) Follow carbon backwash procedures to perform an initial backwash of the tank with the fresh media.

4 CONTINGENCY PLAN

Generally, the required contingencies can be broken down into two major categories: mechanical and remediation type contingencies. Mechanical includes equipment malfunctions or failures, pipe breaks, control malfunctions, etc. Remediation type contingencies include events such as the need to change the design flow rate, increasing contaminant concentrations, and the presence of additional contaminants.

4.1 MECHANICAL CONTINGENCIES

Well Pump. If the well pump fails or its performance is decreased significantly, this condition will be known immediately. Firstly, flow rates will be monitored continuously and the data retrieved on a regular basis through a modem, so a decrease or elimination of flow due to pump failure will be easily recognizable by reviewing the data. Data review will occur daily for the first two weeks of operation, and weekly after that. Additionally, when the flow rate drops below a preset value (initially set at 5 gpm), the data logger will indicate the alarm control mode that will initiate a telephone call to inform personnel of the low flow.

Multi-Media Filter. The only condition that could arise with the filter that would create problems with the treatment system is if an unexpected quantity of suspended solids were present in the influent, and the pressure loss across the filter became excessive. The initial impact of this condition would be the overall decrease in flow rate from the well pump and an increase in-line pressure ahead of the multi-media filter. As with well pump failure, decreased flow would be recognizable when reviewing the flow data retrieved through the modem. If the pressure drop continued to increase dramatically, ultimately the pressure relief valve would open and the flow switch would initiate the alarm mode. If flow were reduced below the low flow set point, the well pump would be shut down via the critical alarm mode.

Granular Activated Carbon. The only mode of failure for the carbon tanks is break-through or over-pressure. Although expected to be very infrequent, break-through of contaminants is an expected occurrence. The carbon will remove all of the VOCs in the influent. VOC monitoring will provide the information needed to identify break-through. This monitoring is described in Section 7.0. Breakthrough from the carbon is not a compliance issue, but rather an operational issue that notifies the operator that the carbon needs to be changed so that

adequate adsorption capacity is available. Once breakthrough is observed, replacement carbon will be immediately ordered and the carbon media in the primary tank replaced as soon as possible.

The other potential mode of failure for the carbon tanks is another operational feature: excessive back pressure up-stream of the carbon tanks. Pressure transducers are located on the influent to each of the operating carbon tanks and wired to the datalogger for monitoring. On-going pressure readings should be reviewed regularly off-site through the modem. In this way, backwash requirements can be anticipated by observing the increasing pressure.

Pipe Rupture/Fitting Leaks. If this event occurs, the leaking water will be collected in the trench drains in the treatment room, where it will flow to the collection sump, and be pumped into the backwash settling tank. If the leak rate exceeds the capacity of the sump pump, high level electrodes in the sump will send a signal to the data logger which will initiate the critical alarm function. Similarly, if the water level in the backwash tank reaches high level probes in the tank, the same alarm function will be initiated.

4.2 REMEDIATION TYPE CONTINGENCIES

Hydraulic Modifications. There is the possibility that after pumping for a period of time and monitoring water level elevations in areal wells, it is determined that the pumping flow rate must be adjusted. The flow rate can be decreased without affecting the treatment system. If the flow rate needs to be increased this is possible with the well pump currently installed. The throttling valve (B3) can be adjusted to reduce the pressure on the pump, which will allow it to pump up to about 50 gpm. All of the pipes, tanks, and pieces of equipment can hydraulically handle flows higher than 50 gpm, if needed. The carbon tanks each have a hydraulic capacity of 50 gpm.

Increased VOC Concentrations. Influent concentrations have been declining since the system began operation; however, if increased concentrations are found, the carbon can easily be changed more frequently.

Additional Volatile Organic Compounds. Volatile organic data from areal well samples collected during the pilot treatability test did not indicate the presence of any additional compounds that were not detected in the pumped ground water from UC22. Should additional compounds that are not removed by carbon be detected, an evaluation of the removal system could be undertaken.

4.3 CRITERIA FOR TRIGGERING CORRECTIVE ACTION

4.3.1 Treatment

The corrective action for the detection of any VOC at concentrations exceeding the discharge

limits in the final discharge after the carbon tanks will be the immediate initiation of change-out of the carbon.

4.3.2 Extraction

The extent of the zone of capture effected by pumping UC22 has demonstrated sustained capture of the UniFirst and Grace source areas. The zone of capture for UC22 may be reduced pending the result of work such as the Combined Effects report, which is required by the Decree.

In the event of a failure of the well pump to maintain the required flowrate, or a complete failure, the corrective action will be to immediately purchase a replacement pump and have it installed.

5 SYSTEM MAINTENANCE

5.1 WEEKLY INSPECTIONS

The treatment system will be inspected on a weekly basis. Any failures, faults or unusual observations will be investigated fully. Any equipment that is found to be faulty, out of adjustment, or in disrepair will be repaired or serviced. Manufacturer's information for the major pieces of equipment is provided in Appendix E. In general, very little on-going maintenance is required for the pieces of equipment utilized in this treatment system. Some recommendations for periodic inspection of the system are presented below.

A. Well Head and Influent Line
   Inspect the well head for evidence of tampering or damage to the well head cap.
B. Data Logger
   Check the data logger for evidence of tampering, short circuits, or possible exposure to excessive moisture.
C. Carbon Tanks
   Check the carbon tanks for leakage, damage or corrosion at the influent, discharge, and drain connections. Inspect the flexible hoses for leakage and damage.
D. Backwash and Reinjection Pumps
   Inspect each pump for worn parts, burn marks, excessive heat and general pump performance. Electrical connections should be checked for damage or evidence of short circuits.
E. Hazardous Waste Storage Area
   Inspect the condition of the drums of spent carbon, the labels and the general condition of the waste storage area. Record the findings on the log sheet.

5.2 ANNUAL SYSTEM INSPECTION

The system operator will perform and document annual inspection tasks. The documentation will consist of completing an annual inspection checklist. The checklist is included in Appendix C. The annual system inspection will generally include the following activities;

- Visual inspection of the wellhead at UC22
- Visual inspection and replacement, as needed, of the desiccant in the pressure transducer junction box at the wellhead at UC22
- Visual inspection of the influent and discharge pipe corridors
- Opening and inspecting the two "at-grade" cleanouts on the discharge pipe
- Visual inspection of conditions at the outfall to the Aberjona
- Visual inspection and exercising of all valves in the treatment system
- Visual inspection of treatment system piping and fittings
- Testing of the emergency eyewash and shower and exercising valves on the municipal water piping of the treatment area
- Visually inspect all the treatment system equipment and valve identification tags and replace as needed. Spare tags and nylon ties are available at the site.
- Visually inspect all tankage, which includes the multi-media filter, the carbon tanks, the backwash settling tank and discharge tank.
- Test the sump pump operation and inspect pump, float and power leads. Clean suction screen on the bottom of the pump.
- Backwash of multi-media filter if not previously performed during the year.
- Inspect and test the pressure relief valve and flow switch
- Inspect and test the high level electrodes in the floor sump and backwash settling tank
- Inspect the floor water seal and containment curbs in the treatment room
- Inventory emergency response equipment and arrange for replacements as needed
- Inventory spare parts for system components and arrange for replacements as needed
- Replacement of the desiccant within the data logger enclosure
- Inspect the cartridge filter and clean the filter element, if necessary.

The results of the inspection (the checklist) and any recommendations resulting from observations during the inspection activities will be submitted to the Design Engineer for review and inclusion in the annual report. The inspection is to be performed during September of each year.

5.3 CONSUMABLE AND SPARE PARTS

5.3.1 Consumable Parts

There are very few moving parts to the System. The majority of the hardware incorporated

into the system is likely to perform for the projected duration of the remedial action.

5.3.2 Spare Parts

Following is a list of spare parts stored at the treatment plant site. This list should be reviewed annually and the parts inventoried. Any parts used should be replaced as soon as possible.

- Tags and nylon ties
1 2" PVC true-union ball valve

Replacement parts are also available on site for the backwash (P4) and the reinject (P5) pumps. These pumps operate on a very infrequent basis and part wear is anticipated to be minor. Refer to the manufacturer's literature in Appendix E for parts list and cut away views of the pumps. These pumps and their parts are distributed by Blake Equipment Company (800-287-0865). Following is a list of the repair parts available at the site for these pumps.

Backwash Pump (P4) by "Burks Pumps" 3 hp - 208 volt,3Y, Model 330GA6-1½

Description	Part #	Part I.D. # in Manufacturer's cut away view
Shaft seal	9917	15
O-ring gasket	22006	12
Shaft sleeve	22063	16
Slinger washer	9918	3
O-ring gasket	22080	9
O-ring gasket	22083	11

Reinjection Pump (P5) by "Burks Pumps" 1/3 hp - 208 volt, 1Y, Model 34CS6M

Description	Part #	Part I.D. # in Manufacturer's cut away view
Impeller	SA-9788-6	23
Raceway	9789-6	22
O-ring gasket	9791	13

6 SITE SECURITY PLAN

The site security procedures outlined in this plan are designed to prevent the unknowing entry, and minimize the possibility of unauthorized entry of persons onto this site during active remediation. The site security procedures outlined herein will also provide insurance that unknowning or unauthorized persons do not come in physical contact with wastes, structures, or equipment that have the potential to cause injury or adverse health effects.

Authorized activities at the site include operation and maintenance of the pumping and treatment equipment and sampling of the water being treated.

6.1 SITE DESCRIPTION

The existing facility at this site is a large warehouse-type structure with the majority of space being utilized as rentable self-storage units. The facility is manned by personnel of the self-storage company from the hours of 8:00 AM to 5:00 PM. The site is encircled by a security fence. The southern property line is Olympia Avenue, and western property line is the top of a retaining wall that is approximately two feet high on the southern end and six feet high on the northern end. The security fence is installed on top of this retaining wall. The northern property line is the right-of-way for Interstate 95/Route 128. The remainder of the property adjoins private residences.

6.2 SITE CONTROLS AND SIGNAGE

Access to the property is controlled by the existence of the security fence that surrounds the facility and a locking gate. During normal business hours, access to the property is controlled by the personnel of the self-storage facility.

The treatment system is located to afford minimal exposure to the general public. Since the entire system is located inside the existing building, the only evidence of activity on-site is the existing well head. All influent and effluent plumbing associated with the treatment system is underground.

The treatment room is secured and isolated by locking doors. Only authorized personnel have keys to obtain access to the site and the treatment room. At each entrance to the treatment room a permanent sign has been affixed with the following legend: Danger - Unauthorized Personnel Keep Out". This sign is legible from a distance of at least 25 feet.

7 LONG-TERM SAMPLING, ANALYSIS AND REPORTING

7.1 REMEDIATION GOALS

The remediation goals for the UniFirst site are essentially defined in the EPA Administrative Order as the remedial objectives. These objectives are:

1) Prevent further migration of contaminated ground water from the source areas to the central area
2) Restore the ground water in the vicinity of the source areas to cleanup levels
3) Prevent public contact with contaminated ground water above the cleanup levels

The clean-up levels referenced in 2) and 3) above are further defined in the Record of Decision and are summarized below:

chloroform	100 µg/L
1,1-Dichloroethane	5 µg/L
1,2-Dichloroethane	5 µg/L
1,1-Dichloroethene	7 µg/L
Tetrachloroethene	5 µg/L
Trichloroethene	5 µg/L
Vinyl chloride	2 µg/L
trans-1,2-Dichloroethene	70 µg/L
1,1,1-Trichloroethane	200 µg/L

7.2 DISCHARGE LIMITS

The discharge limits for the treated water being discharged from this system have been established as follows:

Monthly Average	(µg/L)
Tetrachloroethene	5
Trichloroethene	5
Carbon Tetrachloride	5
1,1 Dichloroethene	7
1,2 Dichloroethene	70
Benzene	5
Lead	10.2 mg/L*

* Based on a hardness of 105 mg/L $CaCO_3$ in the Aberjona River. Maximum discharge limit for lead is 87 µg/L at any point in time (also based on 105 mg/L of $CaCO_3$).

7.3 SAMPLING AND ANALYSIS

7.3.1 Treatment Plant

The frequency of sample collection and parameters to be analyzed for monitoring treatment system operation and compliance with discharge limits is summarized in Table 7-1. The location of the sampling points is shown on Figure 1-2. All samples will be collected, labeled, stored, shipped and analyzed in accordance with the procedures outline in the Quality Assurance/Quality Control Plan for this treatment plant. If discharge sample results indicate violations of any of the discharge limits, a repeat sample for the problem analyte will be initiated. If there is still a violation, the problem must be resolved within 48 hours or the plant must be shut down, and the problem identified and resolved. Upon problem resolution, and/or plant start-up, another sample must be taken immediately.

Table 7-1 Treatment Plant Sampling Frequency

Sample Location	Analyte/Method	Frequency
Influent (S1)	VOC/8260	Bi-Monthly
Between 1st and 2nd Carbon (S5C1)	VOC/8260	Monthly
Between 2nd and 3rd Carbon (S5C2)	VOC/8260	Monthly
Discharge (S6)	VOC/524.2 Lead/200.7 Full TCL/TAL List	Monthly[1] Monthly Annually (May)

Following is a written description of the sampling and analysis requirements for the individual sample locations.

Discharge

Samples of the discharge from the treatment system will be taken from the sample tap labeled S6 located on the discharge line from the final discharge tank. The discharge will be sampled on a monthly basis (depending upon the data) and analyzed for volatile organic compounds via EPA Method 524.2 and lead via EPA Method 200.7. In addition, the full TCL/TAL analyte list will be analyzed for on an annual basis.

Influent

The system influent samples will be taken from the sample tap labeled S1 located immediately downstream of the influent flow sensor and immediately upstream of the Multi-Media filter.

The sampling and analysis for volatile organic compounds will be done using EPA Method 8260.

Between Carbon Tanks

When the order of the carbon tanks is changed, the sampling ports will be labeled according to their position in the treatment train.

Samples from between the carbon units (S5C1 and S5C2) will be collected at least monthly, but may be more frequent if the carbon usage rate indicates that a carbon tank will last less than 6 weeks.

[1] Except **if discharge sample results indicate violations of any of the discharge limits,** a repeat sample will be collected. If there is still a violation, the problem must be resolved within 48 hours, or the plant will be shut down, and the problem identified and resolved. Upon problem resolution, another sample must be taken immediately.

Treatment Plant Solids

Collected (*i.e.*, drummed) treatment plant solids will be sampled when approximately 100 kilograms of solids has accumulated. Samples will be collected using a stainless steel trowel or other proven inert sample collection material and containerized in accordance with the Quality Assurance/Quality Control Plan.

The solids will be analyzed for VOCs using EPA Method 8240 and for TAL metals. If these totals exceed the total criteria for a TCLP extract, a TCLP test will be conducted, the waste characterized, and disposed of in accordance with RCRA land disposal restrictions. Specific references to analytical methods and quality control and sampling criteria are described in the Quality Assurance/Quality Control Plan.

7.3.2 Ground Water

The long-term ground water monitoring plan for the Northeast Quadrant of the Wells G & H Site consists of ground water level monitoring, and ground water sampling and analysis for the volatile organic compounds identified in the ROD. The monitoring plan includes those wells considered necessary to monitor the ground water capture area for well UC22; to evaluate the efficiency of the extraction and treatment system; and to determine compliance with the clean-up criteria specified in the ROD. The Grace wells to be included in this monitoring plan are discussed in the Grace sampling and analysis plan.

Water Level Monitoring

Ground-water-level monitoring will be conducted annually. This monitoring will be conducted on the monitoring wells listed below, which are considered sufficient to confirm the capture zone area for well UC22 in the unconsolidated deposits, shallow bedrock and deep bedrock. The following list of well locations includes all the monitoring wells in the nested location unless otherwise specified:

Monitoring Wells in the Water Level Monitoring Network

DP1S	S65M	UC9-2	UC22*
DP1D	S65DR	UC9-4	UC23-1
DP2S	S66D	UC9-6	UC23-2
DP2M	S67S	UC10S	UC23-3
DP2D	S67M	UC10M	UC23-4
DP3	S67D	UC10D	UC23-5
DP36	S69D	UC10-1	UC24S
DP37S	S70S	UC10-2	UC24D
DP37D	S70M	UC10-3	UC25
K42S	S70D	UC10-4	UC26S
K42M	S71S	UC10-5	UC26D
K42D	S71D	UC10-6	UC29S
GO1S	S81S	UC11-2	UC29D

GO1D	S81M	UC11-6	UC30
GO1DB	S81D	UC12-1	UC31S
IUS1	S82	UC12-2	UC31M
IUS2A	S97S	UC12-3	UC31D
IUS2B	S97M	UC12-4	UG1-1
IUS2C	S97D	UC12-5	UG1-2
IUS3A	UC4	UC12-6	UG1-3
IUS3B	UC5	UC15S	UG1-4
IUS3C	UC6S	UC15D	UG1-5
S7R	UC6	UC16	UG1-6
S63S	UC7A-1	UC17	UG1-7
S63D	UC7A-2	UC18	UC32
S64S	UC7A-3	UC19S	UC33
S64M	UC7A-4	UC19D	UC34
S64D	UC7A-5	UC19	UC35
S65S	UC8	UC20	UC36

Permanently installed data loggers and pressure transducers are installed in monitoring wells UC22, UC6 and UC6S.

Ground Water Sampling

In 1996, EPA approved annual sampling for volatile organic compounds from the following wells:

Monitoring Wells Sampled for VOC

GO1DB	UC6	UC10-2
S70D	UC6S	UC10-3
S71S	UC7-1	UC10-4
S71D	UC7-2	UC10-5
S81S	UC7-3	UC10-6
S81M	UC7-4	UC10S
S81D	UC7-5	UC10M
UG1-4	UC10-1	UC10D
		UC11-2

Ground water is also being monitored bi-monthly at UC22 by way of the treatment system influent samples described in Section 7.3.1.

7.4 REPORTING

Operational reports will be made to the EPA on a monthly basis (within 10 days of the end of each month), and annual summary reports made within 45 days of the end of each operational year. Operational reports include a summary of operational activities, a summary

of analytical data, a graph of the flow, carbon pressure and water level data, field measurements, and a discussion of unusual operational events, adjustments, health and safety measurements and/or observations, and recommendations for continuing operations.

The annual reports contain summaries of all operational and analytical data, discussions of conformance to discharge limits and recommendations for future operational requirements, predictions of carbon use requirements, review of the areal well sampling results, and a discussion regarding comparison of the measured ground water quality versus the clean-up goals as presented in the Record of Decision. In addition, the annual report will include a summary of contaminant mass removed, carbon usage rates, an interpretation of the trends in contaminant concentrations and distributions and recommendations for modifications to the system if necessary. Contaminant concentrations from the individual wells will be presented numerically on the water level contour maps.

7.5 QUALITY ASSURANCE

Quality Assurance is addressed in the Quality Assurance/Quality Control (QA/QC) Plan that is provided as a separate document. The QA/QC Plan addresses sampling and handling methodology, analytical procedures, data reduction, validation, reporting, and equipment calibration.

Appendix A

Design Drawings

POINT OF EXIT THROUGH SLAB INTO 4" DISCHARGE PIPE SEE DETAIL 3/2

4" GRAVITY DISCHARGE PIPE

1" SCH. 40 PVC

BACKWASH REINJECTION

FILTER BACKWASH FEED

FILTER BYPASS

2" MODEL 228B FLOW SENSOR W/TEE

FLOW SWITCH NEMA 4X MODEL FS20 BY WATTS

1" PRESSURE RELIEF VALVE MODEL 250-100 (100psi) BY ITT GRINNELL

ANNUNC. PANEL

CONTROL PANEL

PUMP CONTROLS

2" PVC SDR21 INFLUENT LINE FROM WELL UC22

PRESSURE GAUGE 0-100 PSI

RISER FOR CARBON BACKWASH INFLUENT VALVES G3 & B25 ON RISER

DISCHARGE TANK (3000 GAL)

CARTRIDGE FILTER

SEDIMENT STRAINER

FLOW INDICATOR

2" G.S. PIPING 18"

2" ADAPTOR G.S. TO PVC

36"

MULTI-MEDIA PRESSURE FILTER

2" AUTO-CONTROL BALL VALVE BY G.FISCHER TYPE 105 W/MANUAL OVERRIDE & E420/PE-22 POSITIONER CONTROL WITH MOUNTING BRACKET

DATA LOGGER

POINT OF ENTRY THROUGH SLAB SEE DETAIL 3/2

RISERS FOR ELEVATED LOOP

(HIDDEN)

BACKWASH PUMP

PUMP

BACKWASH SETTLING TANK (3000 GAL)

MANWAY 21" DIA.

SITE TUBE/MANOMETER

S6 ON RISER

FILTER BACKWASH DISCHARGE

SITE TUBE/ MANOMETER

MANWAY 21" DIA.

"ACO DRAIN" SPILL CONTAINMENT CURB (TYP.)

FLOOR TRENCH DRAIN

SUPER HEAVY DUTY DRAIN SYSTEM "ACO DRAIN" MODEL S-100 (TYP.) SEE DETAIL 3/5

CARBON BACKWASH INLET HANG OVERHEAD

CARBON BACKWASH OUTLET HANG OVERHEAD

1 1/2" PVC SCH. 40 SUMP DISCHARGE PIPE,

OFFICE SPACE

NO. 1 CARBON TANK

NO. 2 CARBON TANK

NO. 3 CARBON TANK

NO. 4 CARBON TANK

FLEXIBLE HOSE (TYP.)

16" SQUARE SUPPORT PIER (TYP. OF 4)

EYEWASH & EMERGENCY SHOWER

WATER SUPPLY SHUT-OFF ON RISER

PRESSURE GAUGE

FLOOR TRENCH DRAIN

TEE WITH 1/4" FEMALE N.P.T. AND PRESSURE TRANSDUCER

BW IN

BW OUT

ELECTRICAL PANEL

ELECTRICAL PANEL

4" PVC SDR35 - CUT INTO P.E. SUMP AND SEAL ALL PENETRATIONS (TYP.)

POLYETHYLENE (P.E.) SUMP - SEE DETAIL 1/5

OVERHEAD PIPING

NOTE: ALL PIPING SOLVENT WELD, 2" PVC SCH. 80 EXCEPT WHERE NOTED

WALL TO FLOOR WATER SEAL - SEE DETAIL 6/5

SPILL CONTAINMENT CURB

LEGEND:

GLOBE VALVE

BALL VALVE

GATE VALVE

CHECK VALVE

PRESSURE GAUGE

PRESSURE REGULATOR

SAMPLE TAP

REV.	DATE	DESCRIPTION	BY	APP.

DRAWING TITLE: PIPING LAYOUT

PROJECT: GROUNDWATER TREATMENT SYSTEM WOBURN, MASSACHUSETTS

CLIENT: UNIFIRST CORPORATION WILMINGTON, MASSACHUSETTS

SCALE: NOT TO SCALE

DATE:

DRAWN BY:

DESIGNED BY:

CHECKED BY:

APPROVED BY:

DRAWING NO.

PROJECT NO.

LEGEND

- 2" PVC SCH.80 MAIN PROCESS LINE
- ANCILLARY PIPING AS NOTED
- INSTRUMENT/CONTROL WIRING
- CHECK VALVE
- GATE VALVE
- GLOBE VALVE
- BALL VALVE
- SAMPLE TAP
- PRESSURE TRANSDUCER
- PRESSURE GAUGE
- P — PUMP
- N.C. / N.O. — NORMALLY CLOSED / NORMALLY OPEN

NOTE : CARBON TANKS TO BE OPERATED IN SERIES – AS THREE TANKS – PROCESS ORDER: 1–2–3, 2–3–4, 3–4–1, OR 4–1–2

CR–10 DATA LOGGER & PROGRAMMABLE CONTROLLER

CONTROL PORT (C1–C8)

Second Carbon Tank Pressure Transducer 20 psi
First Carbon Tank Pressure Transducer 50 PSI
Third Carbon Tank Pressure Transducer 20 psi
ROOM TEMPERATURE SENSOR MODEL #107 BY CAMPBELL SCIENTIFIC
INPUT CHANNELS

OMEGA 50 psi
DRUCK 100 psi (UC22)
MONITORING CIRCUIT FOR ANNUNCIATOR #2
CONTROL PORTS TO ANNUNCIATOR #2
TO SDM A04
DATA INDUSTRIAL MODEL 1030 PULSE CHANNEL

RELAY DRIVER AG REL 12 — COM / NO

CALL IN — MODEM — DIAL OUT

STARTER FOR P5

RELAY

MONITORING CIRCUIT FOR ANNUNCIATOR #1

ANNUNCIATOR #1 — S–1, S–2, S–3 — INPUT CHANNEL (TYP.)

ANNUNCIATOR #2 — S–1, S–2, S–3, S–4

2" PVC FILTER BACKWASH EFFLUENT LINE

1.5" PVC SUMP PUMP DISCHARGE

2" PVC CARBON BACKWASH EFFLUENT LINE

B24

SIGHT TUBE

BACKWASH SETTLING TANK
VOLUME = 3000gal
P5 LOW–LEVEL ELECTRODES (N.C.)

HIGH–LEVEL ELECTRODE (CRITICAL ALARM N.O.)

LOCAL STARTER H/O/A

DIFFERENTIAL PRESSURE SWITCH – 10psid

2.0' 1.5'

B19 — SEDIMENT SCREEN — B21 — P5 — B22 — 0–200psi — F5 — B27A — 0–200psi — B27

CARTRIDGE FILTER
MODEL HUR–90–HP BY HARMSCO

BACKWASH SUPER–NATENT REJECT 1" PVC

FLOW INDICATOR — 0–100psi — G8

2" PVC FILTER BYPASS

0–100psi — B2

F3 — F1

G1 — G2

FLEX HOSE – TO PRIMARY CARBON TANK

B21 — 0–30psi — CARBON INFLUENT — PRESSURE TRANSDUCER 50 psi

B32 VENT NO. 1 CARBON TANK — B28 — B36
B33 VENT NO. 2 CARBON TANK — B29 — B37
B34 VENT NO. 3 CARBON TANK — B30 — B38
B35 VENT NO. 4 CARBON TANK — B31 — B39

FLEX HOSE (FROM TERTIARY TANK) — B26

MULTI–MEDIA FILTER
MODEL # ML300 BY BRUNER CORP.

B4 — 0–100psi — F2 — F4

B13 — B7 — B6 — M — POS. DIS. METER (M1)

2" PVC CARBON EFFLUENT

FLOOR TRENCH DRAIN

B23 — 2" PVC CARBON BACKWASH INFLUENT LINE — B25

M/O/A LOCAL STARTER

ROTAMETER — 0–30psi — G3 — B20

0–100psi

S6 — B15 — B16 — B17 — P4 — B11 — B106

SIGHT TUBE

DISCHARGE TANK
OPERATIONAL VOLUME = ~1000gal
TOTAL VOLUME = 3000gal

DISCHARGE TO STORM SEWER

2" PVC FILTER BACKWASH INFLUENT LINE

FLOW MONITOR — FLOW SENSOR — DATA INDUSTRIAL 228B — S1

E1 — ELECTRIC ACTUATOR — AUTO CONTROL VALVE GEORGE FISHER EA20/PC22

B3 — 0–100 psi

FLOW SWITCH — CRITICAL ALARM N.C.

PRESSURE RELIEF VALVE 100 psi

1" PVC RELIEF LINE

FLOOR TRENCH DRAIN

SUMP HIGH–LEVEL ELECTRODES CRITICAL ALARM N.O.

MERCURY FLOAT SWITCH FOR P7

P7 — FLOOR SUMP

PRESSURE TRANSDUCER 100 psi — P1 — UC–22 EXTRACTION WELL

RELAY — SDM A04 ANALOG OUTPUT DEVICE — P1 RESET — STARTER FOR P1

REV.	DATE	DESCRIPTION	BY	APP.

DRAWING TITLE: PROCESS & CONTROL DIAGRAM
PROJECT: GROUNDWATER TREATMENT SYSTEM WOBURN, MASSACHUSETTS
CLIENT: UNIFIRST CORPORATION WILMINGTON, MASSACHUSETTS

SCALE: NONE
DATED: 11/29/00
DRAWN BY:
DESIGNED BY:
CHECKED BY:
APPROVED BY:
SHEET NO.
PROJECT NO.

FILE: 009

Appendix B

Data Logger Control Code

```
;{CR10}
*Table 1 Program
  01: 60.0000    Execution Interval
(seconds)

1:  Z=F (P30)
 1: 0          F
 2: 0          Exponent of 10
 3: 29         Z Loc [ _________ ]

2:  Do (P86)
 1: 18         Set Flag 8 High

3:  Set Port(s) (P20)
 1: 6698       C8..C5 =
1sec/1sec/nc/input
 2: 8999       C4..C1 = input/nc/nc/nc

4:  Full Bridge (P6)
 1: 1          Reps
 2: 23         25 mV 60 Hz Rejection
Range
 3: 4          DIFF Channel
 4: 3          Excite all reps w/Exchan
3
 5: 2500       mV Excitation
 6: 2          Loc [ _________ ]
 7: 23.155     Mult
 8: -81.854    Offset

5:  Z=X (P31)
 1: 2          X Loc [ _________ ]
 2: 7          Z Loc [ _________ ]

6:  Z=X (P31)
 1: 2          X Loc [ _________ ]
 2: 31         Z Loc [ _________ ]

7:  Z=X+Y (P33)
 1: 31         X Loc [ _________ ]
 2: 32         Y Loc [ _________ ]
 3: 32         Z Loc [ _________ ]

8:  Full Bridge (P6)
 1: 1          Reps
 2: 23         25 mV 60 Hz Rejection
Range
 3: 2          DIFF Channel
 4: 2          Excite all reps w/Exchan
2
 5: 2500       mV Excitation
 6: 5          Loc [ _________ ]
 7: 5.0469     Mult
 8: .022       Offset

9:  Volt (Diff) (P2)
 1: 1          Reps
 2: 25         2500 mV 60 Hz Rejection
Range
 3: 1          DIFF Channel
 4: 51         Loc [ _________ ]
 5: .6         Mult
 6: 0          Offset

10:  Volt (Diff) (P2)
 1: 1          Reps
 2: 25         2500 mV 60 Hz Rejection
Range
 3: 3          DIFF Channel
 4: 52         Loc [ _________ ]
 5: .6         Mult
 6: 0          Offset

11:  Volt (Diff) (P2)
 1: 1          Reps
 2: 25         2500 mV 60 Hz Rejection
Range
 3: 5          DIFF Channel
 4: 53         Loc [ _________ ]
 5: 2          Mult
 6: 0          Offset

12:  Pulse (P3)
 1: 1          Reps
 2: 1          Pulse Input Channel
 3: 2          Switch Closure, All
Counts
 4: 12         Loc [ _________ ]
 5: .1051      Mult
 6: 0          Offset

13:  Z=X*F (P37)
 1: 12         X Loc [ _________ ]
 2: 1          F
 3: 13         Z Loc [ _________ ]

14:  Z=X (P31)
 1: 13         X Loc [ _________ ]
 2: 8          Z Loc [ _________ ]

15:  Batt Voltage (P10)
 1: 3          Loc [ _________ ]

16:  Temp (107) (P11)
 1: 1          Reps
 2: 11         SE Channel
 3: 1          Excite all reps w/Exchan
1
 4: 4          Loc [ _________ ]
 5: 1.8        Mult
 6: 32         Offset

17:  Do (P86)
 1: 10         Set Output Flag High
```

```
18:  Set Active Storage Area (P80)
 1: 2        Final Storage Area 2
 2: 511      Array ID

19:  Real Time (P77)
 1: 1120     (Same as 1220) Y,D,Hr/Mn

20:  Sample (P70)
 1: 2        Reps
 2: 2        Loc [ _________ ]

21:  Sample (P70)
 1: 1        Reps
 2: 5        Loc [ _________ ]

22:  Sample (P70)
 1: 1        Reps
 2: 13       Loc [ _________ ]

23:  Sample (P70)
 1: 1        Reps
 2: 50       Loc [ _________ ]

24:  Sample (P70)
 1: 1        Reps
 2: 51       Loc [ _________ ]

25:  Sample (P70)
 1: 1        Reps
 2: 52       Loc [ _________ ]

26:  Sample (P70)
 1: 1        Reps
 2: 53       Loc [ _________ ]

27:  Do (P86)
 1: 1        Call Subroutine 1

28:  If time is (P92)
 1: 0        Minutes (Seconds --)
into a
 2: 60       Interval (same units as
above)
 3: 10       Set Output Flag High

29:  Real Time (P77)
 1: 1120     (Same as 1220) Y,D,Hr/Mn

30:  Resolution (P78)
 1: 1        High Resolution

31:  Sample (P70)
 1: 1        Reps
 2: 1        Loc [ _________ ]

32:  Average (P71)
 1: 1        Reps
 2: 2        Loc [ _________ ]

33:  Average (P71)
 1: 1        Reps
 2: 5        Loc [ _________ ]

34:  Totalize (P72)
 1: 1        Reps
 2: 12       Loc [ _________ ]

35:  Average (P71)
 1: 1        Reps
 2: 13       Loc [ _________ ]

36:  Sample (P70)
 1: 1        Reps
 2: 3        Loc [ _________ ]

37:  Average (P71)
 1: 1        Reps
 2: 51       Loc [ _________ ]

38:  Average (P71)
 1: 1        Reps
 2: 52       Loc [ _________ ]

39:  Average (P71)
 1: 1        Reps
 2: 53       Loc [ _________ ]

40:  If time is (P92)
 1: 10       Minutes (Seconds --)
into a
 2: 60       Interval (same units as
above)
 3: 30       Then Do

41:  Z=F (P30)
 1: 60       F
 2: 0        Exponent of 10
 3: 33       Z Loc [ _________ ]

42:  Z=X/Y (P38)
 1: 32       X Loc [ _________ ]
 2: 33       Y Loc [ _________ ]
 3: 34       Z Loc [ _________ ]

43:  Z=F (P30)
 1: 0        F
 2: 0        Exponent of 10
 3: 32       Z Loc [ _________ ]

44:  If (X<=>F) (P89)
 1: 35       X Loc [ _________ ]
 2: 1        =
 3: 0        F
```

```
 4: 30       Then Do

45:  If Flag/Port (P91)
 1: 24       Do if Flag 4 is Low
 2: 30       Then Do

46:  If (X<=>F) (P89)
 1: 34       X Loc [ _________ ]
 2: 3        >=
 3: 25       F
 4: 30       Then Do

47:  Do (P86)
 1: 8        Call Subroutine 8

48:  Initiate Telecommunications
(P97)
 1: 21       Phone Modem/1200 Baud
 2: 0        Never Disabled
 3: 60       Seconds Call Time Limit
 4: 0        Seconds Before Fast
Retry
 5: 0        Fast Retries
 6: 0        Minutes Before Slow
Retry
 7: 26       Failures Loc [ _________
]
 8: 1        Call-Back ID

49:  Extended Parameters (P63)
 1: 1        Option
 2: 8        Option
 3: 0        Option
 4: 0        Option
 5: 3        Option
 6: 9        Option
 7: 1        Option
 8: 3        Option

50:  Extended Parameters (P63)
 1: 0        Option
 2: 3        Option
 3: 6        Option
 4: 44       Option
 5: 44       Option
 6: 44       Option
 7: 44       Option
 8: 7        Option

51:  Extended Parameters (P63)
 1: 7        Option
 2: 7        Option
 3: 7        Option
 4: 7        Option
 5: 7        Option
 6: 7        Option
 7: 7        Option
 8: 13       Option

52:  End (P95)

53:  End (P95)

54:  End (P95)

55:  End (P95)

56:  If time is (P92)
 1: 0        Minutes (Seconds --)
into a
 2: 1440     Interval (same units as
above)
 3: 10       Set Output Flag High

57:  Real Time (P77)
 1: 1120     (Same as 1220) Y,D,Hr/Mn

58:  Resolution (P78)
 1: 1        High Resolution

59:  Average (P71)
 1: 1        Reps
 2: 2        Loc [ _________ ]

60:  Maximum (P73)
 1: 1        Reps
 2: 10       Value with Hr-Min
 3: 2        Loc [ _________ ]

61:  Minimum (P74)
 1: 1        Reps
 2: 10       Value with Hr-Min
 3: 2        Loc [ _________ ]

62:  Average (P71)
 1: 1        Reps
 2: 5        Loc [ _________ ]

63:  Maximum (P73)
 1: 1        Reps
 2: 10       Value with Hr-Min
 3: 5        Loc [ _________ ]

64:  Minimum (P74)
 1: 1        Reps
 2: 10       Value with Hr-Min
 3: 5        Loc [ _________ ]

65:  Totalize (P72)
 1: 1        Reps
 2: 12       Loc [ _________ ]

66:  Average (P71)
 1: 1        Reps
```

```
 2: 13       Loc [ _________ ]

67:  Maximum (P73)
 1: 1        Reps
 2: 10       Value with Hr-Min
 3: 13       Loc [ _________ ]

68:  Minimum (P74)
 1: 1        Reps
 2: 10       Value with Hr-Min
 3: 13       Loc [ _________ ]

69:  Average (P71)
 1: 1        Reps
 2: 3        Loc [ _________ ]

70:  Average (P71)
 1: 1        Reps
 2: 4        Loc [ _________ ]

71:  Average (P71)
 1: 1        Reps
 2: 51       Loc [ _________ ]

72:  Maximum (P73)
 1: 1        Reps
 2: 10       Value with Hr-Min
 3: 51       Loc [ _________ ]

73:  Minimum (P74)
 1: 1        Reps
 2: 10       Value with Hr-Min
 3: 51       Loc [ _________ ]

74:  Average (P71)
 1: 1        Reps
 2: 52       Loc [ _________ ]

75:  Maximum (P73)
 1: 1        Reps
 2: 10       Value with Hr-Min
 3: 52       Loc [ _________ ]

76:  Minimum (P74)
 1: 1        Reps
 2: 10       Value with Hr-Min
 3: 52       Loc [ _________ ]

77:  If Flag/Port (P91)
 1: 13       Do if Flag 3 is High
 2: 30       Then Do

78:  If Flag/Port (P91)
 1: 14       Do if Flag 4 is High
 2: 0        Go to end of Program
Table

79:  If (X<=>F) (P89)
 1: 13       X Loc [ _________ ]
 2: 4        <
 3: 5        F
 4: 30       Then Do

80:  Beginning of Loop (P87)
 1: 1        Delay
 2: 1        Loop Count

81:  Pulse (P3)
 1: 1        Reps
 2: 1        Pulse Input Channel
 3: 2        Switch Closure, All
Counts
 4: 14       Loc [ _________ ]
 5: .1       Mult
 6: 0        Offset

82:  Z=X*F (P37)
 1: 14       X Loc [ _________ ]
 2: 1        F
 3: 14       Z Loc [ _________ ]

83:  End (P95)

84:  If (X<=>F) (P89)
 1: 14       X Loc [ _________ ]
 2: 4        <
 3: 5        F
 4: 30       Then Do

85:  Do (P86)
 1: 2        Call Subroutine 2

86:  Do (P86)
 1: 28       Set Flag 8 Low

87:  Initiate Telecommunications
(P97)
 1: 21       Phone Modem/1200 Baud
 2: 0        Never Disabled
 3: 60       Seconds Call Time Limit
 4: 0        Seconds Before Fast
Retry
 5: 0        Fast Retries
 6: 0        Minutes Before Slow
Retry
 7: 26       Failures Loc [ _________
]
 8: 1        Call-Back ID

88:  Extended Parameters (P63)
 1: 1        Option
 2: 8        Option
 3: 0        Option
 4: 0        Option
```

```
 5: 3        Option
 6: 9        Option
 7: 1        Option
 8: 3        Option

89:  Extended Parameters (P63)
 1: 0        Option
 2: 3        Option
 3: 6        Option
 4: 44       Option
 5: 44       Option
 6: 44       Option
 7: 44       Option
 8: 2        Option

90:  Extended Parameters (P63)
 1: 2        Option
 2: 2        Option
 3: 2        Option
 4: 2        Option
 5: 2        Option
 6: 2        Option
 7: 2        Option
 8: 13       Option

91:  End (P95)

92:  End (P95)

93:  End (P95)

94:  If (X<=>F) (P89)
 1: 4        X Loc [ _________ ]
 2: 4        <
 3: 35       F
 4: 30       Then Do

95:  Do (P86)
 1: 6        Call Subroutine 6

96:  End (P95)

97:  Read Ports (P25)
 1: 8        Mask (0..255)
 2: 27       Loc [ _________ ]

98:  Read Ports (P25)
 1: 16       Mask (0..255)
 2: 28       Loc [ _________ ]

99:  If Flag/Port (P91)
 1: 13       Do if Flag 3 is High
 2: 30       Then Do

100:  If Flag/Port (P91)
 1: 14       Do if Flag 4 is High
 2: 0        Go to end of Program
Table

101:  If (X<=>F) (P89)
 1: 27       X Loc [ _________ ]
 2: 3        >=
 3: 8        F
 4: 30       Then Do

102:  Do (P86)
 1: 4        Call Subroutine 4

103:  Do (P86)
 1: 28       Set Flag 8 Low

104:  Initiate Telecommunications
(P97)
 1: 21       Phone Modem/1200 Baud
 2: 0        Never Disabled
 3: 60       Seconds Call Time Limit
 4: 0        Seconds Before Fast
Retry
 5: 0        Fast Retries
 6: 0        Minutes Before Slow
Retry
 7: 0        Failures Loc [ _________
]
 8: 1        Call-Back ID

105:  Extended Parameters (P63)
 1: 1        Option
 2: 8        Option
 3: 0        Option
 4: 0        Option
 5: 3        Option
 6: 9        Option
 7: 1        Option
 8: 3        Option

106:  Extended Parameters (P63)
 1: 0        Option
 2: 3        Option
 3: 6        Option
 4: 44       Option
 5: 44       Option
 6: 44       Option
 7: 44       Option
 8: 4        Option

107:  Extended Parameters (P63)
 1: 4        Option
 2: 4        Option
 3: 4        Option
 4: 4        Option
 5: 4        Option
 6: 4        Option
 7: 4        Option
```

```
 8: 13       Option

108:  End (P95)

109:  End (P95)

110:  If Flag/Port (P91)
 1: 13       Do if Flag 3 is High
 2: 30       Then Do

111:  If (X<=>F) (P89)
 1: 28       X Loc [ _________ ]
 2: 3        >=
 3: 16       F
 4: 30       Then Do

112:  Do (P86)
 1: 5        Call Subroutine 5

113:  Do (P86)
 1: 28       Set Flag 8 Low

114:  If Flag/Port (P91)
 1: 28       Do if Flag 8 is Low
 2: 30       Then Do

115:  Beginning of Loop (P87)
 1: 2        Delay
 2: 0        Loop Count

116:  If (X<=>F) (P89)
 1: 29       X Loc [ _________ ]
 2: 3        >=
 3: 2        F
 4: 31       Exit Loop if True

117:  Do (P86)
 1: 28       Set Flag 8 Low

118:  Initiate Telecommunications
(P97)
 1: 21       Phone Modem/1200 Baud
 2: 8        Disabled when User Flag
8 is High
 3: 60       Seconds Call Time Limit
 4: 0        Seconds Before Fast
Retry
 5: 0        Fast Retries
 6: 0        Minutes Before Slow
Retry
 7: 26       Failures Loc [ _________
]
 8: 1        Call-Back ID

119:  Extended Parameters (P63)
 1: 1        Option
 2: 8        Option
 3: 0        Option
 4: 0        Option
 5: 3        Option
 6: 9        Option
 7: 1        Option
 8: 3        Option

120:  Extended Parameters (P63)
 1: 0        Option
 2: 3        Option
 3: 6        Option
 4: 44       Option
 5: 44       Option
 6: 44       Option
 7: 44       Option
 8: 6        Option

121:  Extended Parameters (P63)
 1: 6        Option
 2: 6        Option
 3: 6        Option
 4: 6        Option
 5: 6        Option
 6: 6        Option
 7: 6        Option
 8: 13       Option

122:  Do (P86)
 1: 18       Set Flag 8 High

123:  Z=Z+1 (P32)
 1: 29       Z Loc [ _________ ]

124:  End (P95)

125:  End (P95)

126:  End (P95)

127:  End (P95)

128:  If (X<=>F) (P89)
 1: 2        X Loc [ _________ ]
 2: 3        >=
 3: 15       F
 4: 30       Then Do

129:  If (X<=>F) (P89)
 1: 8        X Loc [ _________ ]
 2: 4        <
 3: 25       F
 4: 30       Then Do

130:  Z=F (P30)
 1: 5000     F
 2: 0        Exponent of 10
 3: 50       Z Loc [ _________ ]
```

```
131:  SDM-AO4 (P103)
 1: 1         Reps
 2: 0         SDM Address
 3: 50        Loc [ _________ ]

132:  End (P95)

133:  If (X<=>F) (P89)
 1: 8         X Loc [ _________ ]
 2: 3         >=
 3: 25        F
 4: 30        Then Do

134:  If (X<=>F) (P89)
 1: 8         X Loc [ _________ ]
 2: 4         <
 3: 75        F
 4: 9         Call Subroutine 9

135:  End (P95)

136:  End (P95)

137:  CASE (P93)
 1: 7         Case Loc [ _________ ]

138:  If Case Location < F (P83)
 1: 15        F
 2: 30        Then Do

139:  Z=X*F (P37)
 1: 7         X Loc [ _________ ]
 2: 167       F
 3: 50        Z Loc [ _________ ]

140:  SDM-AO4 (P103)
 1: 1         Reps
 2: 0         SDM Address
 3: 50        Loc [ _________ ]

141:  End (P95)

142:  End (P95)

143:  If Flag/Port (P91)
 1: 12        Do if Flag 2 is High
 2: 30        Then Do

144:  If Flag/Port (P91)
 1: 11        Do if Flag 1 is High
 2: 3         Call Subroutine 3

145:  End (P95)

146:  If Flag/Port (P91)
 1: 11        Do if Flag 1 is High
 2: 30        Then Do

147:  If Flag/Port (P91)
 1: 12        Do if Flag 2 is High
 2: 7         Call Subroutine 7

148:  End (P95)

149:  Do (P86)
 1: 15        Set Flag 5 High

*Table 2 Program
  01: 0.0000    Execution Interval
(seconds)

1:  Full Bridge (P6)
 1: 1         Reps
 2: 23        25 mV 60 Hz Rejection
Range
 3: 4         DIFF Channel
 4: 3         Excite all reps w/Exchan
3
 5: 2500      mV Excitation
 6: 30        Loc [ _________ ]
 7: 23.155    Mult
 8: -84.541   Offset

2:  Volt (Diff) (P2)
 1: 1         Reps
 2: 25        2500 mV 60 Hz Rejection
Range
 3: 5         DIFF Channel
 4: 53        Loc [ _________ ]
 5: 2.6       Mult
 6: 0         Offset

3:  Volt (Diff) (P2)
 1: 1         Reps
 2: 25        2500 mV 60 Hz Rejection
Range
 3: 1         DIFF Channel
 4: 51        Loc [ _________ ]
 5: .64       Mult
 6: 1.6       Offset

4:  Volt (Diff) (P2)
 1: 1         Reps
 2: 25        2500 mV 60 Hz Rejection
Range
 3: 3         DIFF Channel
 4: 52        Loc [ _________ ]
 5: .65       Mult
 6: -.8       Offset

*Table 3 Subroutines

1:  Beginning of Subroutine (P85)
```

```
 1: 1        Subroutine 1

2:  Z=F (P30)
 1: 0        F
 2: 1        Exponent of 10
 3: 18       Z Loc [ _________ ]

3:  Time (P18)
 1: 1        Minutes into current day
(maximum 1440)
 2: 0        Mod/By
 3: 15       Loc [ _________ ]

4:  Set Active Storage Area (P80)
 1: 3        Input Storage Area
 2: 23       Loc [ _________ ]

5:  Do (P86)
 1: 10       Set Output Flag High

6:  Real Time (P77)
 1: 100      Day (midnight = 0000)

7:  Do (P86)
 1: 20       Set Output Flag Low

8:  Set Active Storage Area (P80)
 1: 1        Final Storage Area 1
 2: 1        Array ID

9:  Z=F (P30)
 1: 1440     F
 2: 0        Exponent of 10
 3: 16       Z Loc [ _________ ]

10:  Z=X/Y (P38)
 1: 15       X Loc [ _________ ]
 2: 16       Y Loc [ _________ ]
 3: 17       Z Loc [ _________ ]

11:  Z=X+Y (P33)
 1: 23       X Loc [ _________ ]
 2: 17       Y Loc [ _________ ]
 3: 25       Z Loc [ _________ ]

12:  Z=X-Y (P35)
 1: 25       X Loc [ _________ ]
 2: 18       Y Loc [ _________ ]
 3: 1        Z Loc [ _________ ]

13:  End (P95)

14:  Beginning of Subroutine (P85)
 1: 2        Subroutine 2

15:  Do (P86)
 1: 78       Pulse Port 8

16:  Do (P86)
 1: 10       Set Output Flag High

17:  Set Active Storage Area (P80)
 1: 2        Final Storage Area 2
 2: 0        Array ID

18:  Real Time (P77)
 1: 1120     (Same as 1220) Y,D,Hr/Mn

19:  Sample (P70)
 1: 1        Reps
 2: 12       Loc [ _________ ]

20:  Do (P86)
 1: 14       Set Flag 4 High

21:  End (P95)

22:  Beginning of Subroutine (P85)
 1: 3        Subroutine 3

23:  Do (P86)
 1: 78       Pulse Port 8

24:  Do (P86)
 1: 22       Set Flag 2 Low

25:  End (P95)

26:  Beginning of Subroutine (P85)
 1: 4        Subroutine 4

27:  Do (P86)
 1: 78       Pulse Port 8

28:  Do (P86)
 1: 10       Set Output Flag High

29:  Set Active Storage Area (P80)
 1: 2        Final Storage Area 2
 2: 0        Array ID

30:  Real Time (P77)
 1: 1120     (Same as 1220) Y,D,Hr/Mn

31:  Sample (P70)
 1: 1        Reps
 2: 27       Loc [ _________ ]

32:  Do (P86)
 1: 14       Set Flag 4 High

33:  End (P95)

34:  Beginning of Subroutine (P85)
```

```
 1: 5        Subroutine 5

35:  Do (P86)
 1: 10       Set Output Flag High

36:  Set Active Storage Area (P80)
 1: 2        Final Storage Area 2
 2: 0        Array ID

37:  Real Time (P77)
 1: 1120     (Same as 1220) Y,D,Hr/Mn

38:  Sample (P70)
 1: 1        Reps
 2: 28       Loc [ _________ ]

39:  Do (P86)
 1: 16       Set Flag 6 High

40:  End (P95)

41:  Beginning of Subroutine (P85)
 1: 6        Subroutine 6

42:  Do (P86)
 1: 77       Pulse Port 7

43:  Do (P86)
 1: 10       Set Output Flag High

44:  Set Active Storage Area (P80)
 1: 2        Final Storage Area 2
 2: 0        Array ID

45:  Real Time (P77)
 1: 1120     (Same as 1220) Y,D,Hr/Mn

46:  Sample (P70)
 1: 1        Reps
 2: 4        Loc [ _________ ]

47:  Do (P86)
 1: 17       Set Flag 7 High

48:  End (P95)

49:  Beginning of Subroutine (P85)
 1: 7        Subroutine 7

50:  Do (P86)
 1: 78       Pulse Port 8

51:  Do (P86)
 1: 21       Set Flag 1 Low

52:  End (P95)

53:  Beginning of Subroutine (P85)
 1: 9        Subroutine 9

54:  Z=1/X (P42)
 1: 8        X Loc [ _________ ]
 2: 8        Z Loc [ _________ ]

55:  Z=F (P30)
 1: 125      F
 2: 3        Exponent of 10
 3: 10       Z Loc [ _________ ]

56:  Z=X*Y (P36)
 1: 8        X Loc [ _________ ]
 2: 10       Y Loc [ _________ ]
 3: 50       Z Loc [ _________ ]

57:  SDM-AO4 (P103)
 1: 1        Reps
 2: 0        SDM Address
 3: 50       Loc [ _________ ]

58:  End (P95)

59:  Beginning of Subroutine (P85)
 1: 8        Subroutine 8

60:  Z=F (P30)
 1: 1        F
 2: 0        Exponent of 10
 3: 35       Z Loc [ _________ ]

61:  Do (P86)
 1: 10       Set Output Flag High

62:  Set Active Storage Area (P80)
 1: 2        Final Storage Area 2
 2: 0        Array ID

63:  Real Time (P77)
 1: 1120     (Same as 1220) Y,D,Hr/Mn

64:  Sample (P70)
 1: 1        Reps
 2: 35       Loc [ _________ ]

65:  Sample (P70)
 1: 1        Reps
 2: 34       Loc [ _________ ]

66:  End (P95)

End Program

-Input Locations-
1 _________ 1 1 1
2 _________ 1 8 1
```

3 _____ 1 3 1
4 _____ 1 3 1
5 _____ 1 5 1
6 _____ 0 0 0
7 _____ 1 2 1
8 _____ 1 5 2
9 _____ 0 0 0
10 _____ 1 1 1
11 _____ 0 0 0
12 _____ 1 4 1
13 _____ 1 7 1
14 _____ 1 2 2
15 _____ 1 1 1
16 _____ 1 1 1
17 _____ 1 1 1
18 _____ 1 1 1
19 _____ 0 0 0
20 _____ 0 0 0
21 _____ 0 0 0
22 _____ 0 0 0
23 _____ 1 1 1
24 _____ 0 0 0
25 _____ 1 1 1
26 _____ 1 0 3
27 _____ 1 2 1
28 _____ 1 2 1
29 _____ 1 1 2
31 _____ 1 1 1
32 _____ 1 2 2
51 _____ 1 5 2
52 _____ 1 5 2
53 _____ 1 2 2
50 _____ 1 4 3
33 _____ 1 1 1
34 _____ 1 2 1
35 _____ 1 2 1
30 _____ 1 0 1
-Program Security-
0
0
0
-Mode 4-
-Final Storage Area 2-
6200

Appendix C

Field Operation Forms

System Operation Log
Quarterly Sensor Calibration Log
Annual System Inspection Check List
Alarm Response Log

Operation Log

UniFirst Ground Water Treatment System
Woburn, Massachusetts

Date _____
Time _____
Operator _____

Purpose: O Routine O Maintenance
O Sampling O Carbon Change

Comments: _____

CR-10 Keypad Display Data	Key	Reading	Units
Time	* 5	_____	
UC22 Water Elevation	* 6 2 A	_____	ft
Carbon Pressure Influent	* 6 5 A	_____	psi
Carbon Pressure Pri/Sec	* 6 51 A	_____	psi
Carbon Pressure Sec/Tert	* 6 52 A	_____	psi
Flow Rate	* 6 13 A	_____	gpm
Annunciator #1 Status	* 6 27 A	_____	
Annunciator #2 Status	* 6 28 A	_____	
Tank Pressure MMF	* 6 53 A	_____	psi
Signal to Auto-Control Valve B1	* 6 50 A	_____	mV

Flags (* 6 A D)

1 O Reserved (ON)
2 O Low Flow Alarm (OFF)
3 O Alarm Detection Active (ON)
4 O Annuc #1 Alarm Active (OFF)
5 O Normal Operation (ON)
6 O Annuc #2 Alarm Active (OFF)
7 O Room Temp Alarm Active (OFF)
8 O Dial-Out Active (ON)

Influent Stream/Multi-Media Filter

Inlet Pressure upstream of Valve B3: _____ psig

pH _____

Pressure at MM Filter:
Inlet: _____ psig
Outlet: _____ psig
△= _____ psig

Backwash Initiated:
O Yes O No
(if YES, fill out Pump P4 Section)

Tanks

Discharge Tank Level: _____ ft above floor
Backwash Tank Level: _____ ft above floor

Reinject Initiated: O Yes O No
(if YES, fill out Pump P5 Section)

Carbon Tanks

Process Order: O 1-2-3 O 2-3-4 O 3-4-1 O 4-1-2

Pressure:

Primary In: _____ psig
Secondary In: _____ psig
△= _____ psig

Secondary In: _____ psig
Tertiary In: _____ psig
△= _____ psig

Tertiary In: _____ psig
Tertiary Out: _____ psig
△= _____ psig

Backwash Initiated: O Yes O No
(if YES, fill out Pump P4 Section)

Hazardous Waste Storage Area _____ # Containers in storage

O Yes O No Are the containers closed?
O Yes O No Are the containers properly labeled?
O Yes O No Are the containers in good condition?
O Yes O No Is the floor clean?
O Yes O No Are the aisles clear?

Describe any Corrections _____ Date of Corrections _____

Backwash Pump P4

Operation: O MM Filter O Carbon 1 O Carbon 2 O Carbon 3 O Carbon 4

Start: Time ____:____ Level _____ ft above floor Pressure at Pump Discharge _____ psig

Stop: Time ____:____ Level _____ ft above floor

Duration: _____ min _____ change x 330.5 gal/ft = _____ gallons

Final Readings after backwash:

Inlet: _____ psig

Outlet: _____ psig

△= _____ psig

Re-Inject Pump P5

Start Time ____:____

Cartridge Filter Pressure: Upstream _____ psig

Downstream _____ psig

△= _____ psig

Pressure at Injection Point: _____ psig

Filter Cartridge: O Replaced

Comments

_____

_____

_____

_____

_____

_____

_____

_____

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Quarterly Sensor Calibration

UniFirst Ground Water Treatment System
Woburn, Massachusetts

Date _____
Time _____
Operator _____

I. Synchronize a watch with the data logger time (*5).

II. Flow Sensor Calibration Check

The flow sensor is to be compared to the mechanical meter, M1.

1.) Divert flow through M1.
   a.) Open valves B6 and B7.
   b.) Close valve B13.
2.) Record flow rate.
   a.) Using a watch and the sweep hand of the meter, record the number of gallons in one minute and the time at the end of the reading in 4.b.i.
3.) Reset valves for normal operation.
   a.) Open valve B13.
   b.) Close valves B6 and B7.
4.) Retrieve data and check accuracy.
   a.) Review the data logger values for the time the manual flow measurement was taken (see O&M Manual, Appendix C, Section B 3.5) and record the value in 4.b.ii.
   b.) Compare the flow rates.
      i. M1 Flow Rate _____ gpm Time _____
      ii. Data Logger Value _____ gpm

$$Accuracy = \frac{\text{M1 Flow - DataLogger Flow}}{\text{M1 Flow}} * 100$$

_____ - _____ *100 = _____

If the accuracy is greater than 2%, run calibration procedure again.
If the accuracy continues to exceed 2%, consult with the Design Engineer.

III. UC22 Pressure Transducer Calibration Check

The water level in the extraction well (UC22) as measured by the pressure transducer is compared to a manual water level measurement.

1.) Measure the water level in UC22.
   a.) Unlock the monitoring tube port at the UC22 well head.
   b.) Using a water level tape, measure the depth to water from the v-notch in the top of the casing. Record the measurement and time in 2.b.i.
   c.) Decontaminate the water level probe and lock the well head.
2.) Retrieve data and check accuracy.
   a.) Review the data logger values for the time the water level measurement was taken (see O&M Manual, Appendix C, Section B 3.5) and record the value in 2.b.ii.
   b.) Calculate water level elevation by subtracting the depth to water from the well head elevation.

      Well Head Elevation 85.53 feet
      i. Depth to Water _____ feet Time _____
      Manual Water Elevation _____ feet (subtract depth from elevation)
      ii. Data Logger Elevation _____ feet

$$Accuracy = \frac{\text{Manual Elev - DataLogger Elev}}{\text{Manual Elev}} * 100$$

_____ - _____ *100 = _____

If the accuracy is greater than 2%, run calibration procedure again.
If the accuracy continues to exceed 2%, consult with the Design Engineer.

IV. Well Head Junction Box Desiccant

a.) View the desiccant, "DRI-CAN", indicator through the window in the junction box.

b.) If the indicator is pink, the DRI-CAN has reached saturation and must be replaced.

V. Pressure Transducer at Carbon Tank Calibration Check

The pressure indicated on the gauge upstream of the first carbon unit is compared to the pressure recorded by the data logger.

1.) Read carbon pressure.

a.) Record the pressure indicated on the transducer pressure gauge and the time in 2.b.i.

2.) Retrieve data and check accuracy.

a.) Review the data logger values for the time the carbon pressure reading was taken (see O&M Manual, Appendix C, Section B 3.5) and record the value in 2.b.ii.

b.) Calculate accuracy.

i. Transducer Pressure _____ psi Time _____

ii. Data Logger Pressure _____ psi

$$Accuracy = \frac{\text{Trans. Press - DataLogger Press}}{\text{Trans Press}} * 100$$

_____ - _____ *100 = _____

If the accuracy is greater than 2%, run calibration procedure again.

If the accuracy continues to exceed 2%, consult with the Design Engineer.

VI. Test Pump (P1) Control Circuit

The control circuit is tested by simulating a high water condition in the floor sump.

1.) Immerse the electrodes for the floor sump in a container of water and record the responses:

a.) Power dropped to Pump P1: O Yes O No

b.) Annunciator #2 energized: O Yes O No

c.) Call-out routine initiated: O Yes O No

If any of these responses do not occur, consult with the Design Engineer.

Annual Inspection Report

UniFirst Ground Water Treatment System
Woburn, Massachusetts

Date _____
Operator _____

I. UC22 Well Head

Remove any debris around the well head.

Condition of well cap _____

Signs of wear or abuse o Yes o No Describe _____

Condition of pressure transducer junction box _____

Condition of desiccant (replace if pink) _____

II. Influent Pipe Corridor

Evidence of settlement o Yes o No

Evidence of leakage o Yes o No

III. Discharge Pipe Corridor

Evidence of settlement o Yes o No

Evidence of leakage o Yes o No

Open and inspect the two cleanouts located at 90° bends on the discharge line.

Remove valve box cover and 4" threaded plug.

Condition of 1st cleanout (outside treatment room) _____

Condition of 2nd cleanout (@NW corner of site) _____

IV. Discharge Outfall at the Aberjona River

Describe conditions _____

V. Treatment System Piping and Valving

Inspect all piping, fittings and valving for leakage and signs of rust. With the treatment system off, exercise all valves through their complete range of operation and restore to their original position. Complete the following table to assure that every valve is exercised. Indicate the sequence of operation: Found Open - Closed - Left Open (OCO) or Found Closed - Opened - Left Closed (COC). Inspect and indicate the condition of each valve tag, replace as needed and so note on the table.

Valve Inspection & Exercise Record

Valve	Exercise Sequence	ID Tag Condition	Valve	Exercise Sequence	ID Tag Condition
B1			B12		
B2			B13		
B4			B14		
B6			B15		
B7			B16		
B11			B17		

Valve Inspection & Exercise Record

Valve	Exercise Sequence	ID Tag Condition	Valve	Exercise Sequence	ID Tag Condition
B19			B35		
B20			B36		
B21			B37		
B22			B38		
B23			B39		
B24			B106		
B25					
B26			G-1		
B27			G-2		
B27A			G-3		
B28			G-6		
B29					
B30			F1		
B31			F2		
B32			F3		
B33			F4		
B34			F5		

VI. Treatment System Tankage

Visually inspect the tankage associated with the treatment system. This includes: the multi-media filter; the carbon tanks; the backwash settling tank; and the discharge tank; Inspect the tanks for general condition, at every weld or seam and at each pipe connection.

Multi-Media Filter

General Condition _____

Condition of Welds _____

Condition at pipe penetrations _____

Cartridge Filter

General Condition _____

Condition of Welds _____

Carbon Tanks

General Condition _____

Condition at pipe penetrations _____

Backwash Settling Tank

General Condition _____

Condition at pipe penetrations _____

Discharge Tank

General Condition _____

Condition at pipe penetrations _____

VII. Backwash Multi-media Filter

Backwash the multi-media filter following the procedure in Section 3.4.1 of the O&M Manual. Backwash to be performed during the Annual Inspection, unless previously accomplished during the year of operation.

Backwash Performed: _____ Duration (minutes): _____

VIII. Cartridge Filter

Open cartridge and remove filter element.
Clean the filter element per the manufacturer's recommendations.
Collect the rinsate in a drum designated for this purposed.

IX. Floor Sump Pump (P7)

Inspect and test the floor sump.

General Condition _____

Pump Operation _____

Clean suction screen on bottom of pump.

X. Hydrogen Peroxide Containment Structure

Inspect the containment structure and lining. Remove any debris that may have accumulated.

General Condition _____

Liner Condition _____

XI. Floor to Wall Seal and Containment Curbs

Inspect the condition of the floor to wall seal along the south and west walls of the treatment room. Check the seal for tears, abrasions and continuity with the walls and floor. Inspect the containment curbing at the doors to the treatment room and those adjacent to the discharge tank. Check to assure the curbing is bonded to the concrete slab.

Floor to Wall Seal general condition _____

Containment curbs general condition _____

XII. Emergency Eyewash/Shower

Test and inspect the emergency eyewash and shower.

Eyewash - tested o Yes o No General condition _____

Shower - tested o Yes o No General condition _____

XIII. Pressure Relief Valve and Flow Switch

Test and inspect the pressure relief valve (system must be operating) and the flow switch.

Test pressure relief valve and note response:

Well Pump (P1) shut down?	O Yes	O No
Annunciator #2 Lit?	O Yes	O No
Dial Out Routine Activated?	O Yes	O No

Relief value and flow switch general condition _____

XIV. High Level Electrodes - Backwash Tank & Floor Sump

Test and inspect the high level electrode assemblies for the backwash settling tank and floor sump.
Disconnect the modem telephone line to avoid alarm callouts.
Simulate a high level condition by immersing the sensors in a container of water. Test the level sensors with the well pump operating and note the responses.

Backwash Settling Tank

Test high level electrodes and note response:

Well Pump (P1) shut down?	O Yes	O No
Annunciator #1 Lit?	O Yes	O No

General condition of the electrode assembly _____

Floor Sump

Test high level electrodes and note response:

Well Pump (P1) shut down?	O Yes	O No
Annunciator #2 Lit?	O Yes	O No

General condition of the electrode assembly _____
Remember to reconnect the modem telephone line.

XV. Ventilation System

Test the operation of and inspect the vent fan and make-up louvers.

Vent Fan

Test Operation _____ General Condition _____

Make-up Air Louvers

Test Operation _____ General Condition _____

XVI. Data Logger

Open the datalogger enclosure and replace the desiccant.

XVII. Recommendations

Record below any recommendations to the treatment system operation or maintenance.

Alarm Response Log

UniFirst Ground Water Treatment System

Woburn, Massachusetts

Complete this form whenever an alarm condition shuts down the system

Response Date: _____ Alarm Date: _____

Response Time: _____ Alarm Time: _____

Responding Operator: _____ Pager Codes Received: _____

CR-10 Keypad Display Data	Key	Reading
Time	* 5	_____
Annunciator #1 Status	* 6 27 A	_____
Annunciator #2 Status	* 6 28 A	_____

Audible Alarm O Yes O No

Annunciator #1 Indicator Lamps

Backwash O On O Off

Annunciator #2 Indicator Lamps

Well Pump O On O Off

Low Room Temp O On O Off

Flags (* 6 A D)

1 O Reserved (ON)
2 O Low Flow Alarm (OFF)
3 O Alarm Detection Active (ON)
4 O Annuc #1 Alarm Active (OFF)
5 O Normal Operation (ON)
6 O Annuc #2 Alarm Active (OFF)
7 O Room Temp Alarm Active (OFF)
8 O Dial-Out Active (ON)

Cause of Alarm _____

_____

_____

_____

Repairs/Services Undertaken _____

_____

_____

_____

System Restarted

Date: _____

Time: _____

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Appendix D

Valve & Equipment Schedules
Valve Startup Positions

Equipment Schedule

Components

Unit	Manufacturer	Model #	Design Flow (gpm)	Max Pressure (psi)	Maximum Delta Pressure (psi)
Multi-Media Filter	Bruner	MS-30-2-G	50 to 75	100	18
Carbon Tank (4)	Pentair	31647	50	150	15
Cartidge Filter	Harmsco	HUR-90-HP	2 to 7	150	15

Pressure Relief Valve

Size	Manufacturer	Model #	Location & Set Pressure
3/4"	Watts	M3- H174A	Upstream of auto-control valve 100 psi set pressure

Automatic Control Valve

Size	Manufacturer	Model #	Location	Purpose
2"	George Fischer	EA20 Elec Actuator, PE22 Positioner	Process piping upstream of flow sensor	Receives voltage signal from datalogger to control flowrate to maintain pumping elevation in UC22

Pump Schedule

Pump	Manufacturer	Model #	HP	Volt	Phase	Function	Operating Points	Shut-Off Head
P1	Grundfos	40S30-9	3	208	3	Well pump discharge to system	185 ft TDH @ 55 gpm	250
P4	Burks Pumps	330GA6-1½	3	208	3	Provides backwash to MMF and carbon tanks	99 ft TDH @ 75 gpm for MMF backwash 103 ft TDH at 50 gpm for carbon backwash	108 ft
P5	Burks Pumps	34CS6M	1/3	208	1	Pumps settled backwash back into system	120 ft TDH @4.5 gpm	200 ft
P7	Zoeller	M267F	1/2	115	1	Sump Pump	15 ft TDH @50 gpm	21.5 ft
P8	WaterAce	R6S	1/6	115	1	Spare utility pump		

Meter Schedule

Rotameter

Location	Manufacturer	Model	Size	Range	Purpose
Riser from Pump P4 to carbon backwash	Omega	FL-75M	2"	20 to 100 gpm	Measure backwash flowrate to carbon tanks

Flow Sensor & Monitor

Location	Manufacturer	Model #	Range	Signal	Purpose
Flow sensor in process piping downstream of auto control valve	Data Industrial	228-B	1 to 30 ft/sec	Proportional (frequency)	Provides input to flow monitor
Flow monitor in front of data logger panel	Data Industrial	1000	0.5 to 40 inch pipe diameter calibration range	Pulse (frequency)	Displays flow rate and total flow Provides input to data logger

Water Meter

Designation	Manufacturer	Model #	Size	Location	Purpose
M1	Neptune	T-10	2"	Side loop before carbon units	Compare flowrate from sensors

Sensor Schedule

Pressure Transducers

Location	Manufacturer	Model #	Rating (psi)	Signal	Purpose
In pumping well UC-22	Druck	PDCR 940	100	Proportional (mV)	Monitor drawdown & provide input data to auto valve
Upstream of Carbon Tanks	Omega	PX-800-050GV	50	Proportional (mV)	Monitor carbon tank pressure
Between Primary & Secondary Carbon	Omega	PX612-030GV	30	Proportional (mV)	Monitor carbon tank pressure
Between Secondary & Tertiary Carbon	Omega	PX612-030GV	30	Proportional (mV)	Monitor carbon tank pressure
Upstream of MMF	Omega	PX612-100GV	100	Proportional (mV)	Monitor MMF influent pressure

Level Electrodes

Location	Manufacturer	Model #	Number	Configuration	Purpose
In floor sump	B/W Controls	6013-SS-X-A, Solid Rod	2	N.O.	Shuts down system if high level in sump
In backwash settling tank	B/W Controls	6013-W10-15, Wire Suspension	3	N.O.	Shuts down system if high level in tank
				N.C.	Shuts down Pump P5 2.0 ft above suction level

Differential Pressure Switch

Location	Manufacturer	Model #	Range	Rating	Purpose
At cartridge filter	WE Anderson	H3A-3	5 to 70 psid	1500 psi	Shuts down Pump P5 when pressure differential exceeds 15 psi

Flow Switch

Location	Manufacturer	Model #	Configuration	Rating	Purpose
At pressure relief valve	Watts	FS20	N.O.	150 psi	Shuts down system if flow sensed in pressure relief line

Temperature Sensor

Location	Manufacturer	Model #	Range	Purpose
On wall near datalogger	Campbell Scientific	107	-33deg C to +48 Deg C	Tracks treatment room temperature

Valve Schedule

Designation	Size	Normal Position	Location	Purpose
Ball Valves				
B1	2"	Varies	Influent piping	Auto regulates flow to maintain drawdown
B2	2"	N.O.	Upstream of MM filter	Close to bypass MMF
B3	2"	N.O.	At inlet piping	Regulates system flow
B4	2"	N.O.	At MMF discharge	Closed during backwash
B6	2"	N.C.	Upstream of meter M1	Open to check flow rate
B7	2"	N.C.	Downstream of meter M1	Open to check flow rate
B13	2"	N.O.	On discharge line	Bypass meter M1 loop
B14	2"	N.O.	On final discharge line	Isolate discharge tank
B15	2"	N.O.	At discharge tank	Isolate discharge tank
B16	2"	N.O.	On discharge line	Closed during backwash
B17	2"	N.C.	On Pump P4 suction	Isolate pump - open during backwash
B19	1"	N.C.	Suction on Pump P5	Isolate sediment strainer
B20	2"	N.C.	On Pump P4 discharge	Open to backwash filter
B21	2"	N.O.	Carbon Tank Influent	Open during regular operations
B22	1"	N.C.	On Pump P5 discharge	Isolate pump/cartridge filter
B23	2"	N.C.	Carbon backwash influent line	Open for backwash
B24	2"	N.C.	Carbon backwash effluent line	Open for backwash
B25	2"	N.C.	On Pump P4 discharge	Open to backwash carbon
B26	2"	N.O.	Carbon Tank Effluent	Open during regular operations
B27 & B27A	1"	N.C.	Downstream of cartridge filter	Isolate cartridge filter
B28	2"	Varies	Carbon Tank #1	Influent to tank
B29	2"	Varies	Carbon Tank #2	Influent to tank
B30	412	Varies	Carbon Tank #3	Influent to tank
B31	2"	Varies	Carbon Tank #4	Influent to tank
B32	1/2"	N.C.	Top of Carbon #1	Air Vent
B33	1/2"	N.C.	Top of Carbon #2	Air Vent
B34	1/2"	N.C.	Top of Carbon #3	Air Vent
B35	1/2"	N.C.	Top of Carbon #4	Air Vent
B36	2"	Varies	Carbon Tank #1	Effluent from tank/Drain
B37	2"	Varies	Carbon Tank #2	Effluent from tank/Drain
B38	2"	Varies	Carbon Tank #3	Effluent from tank/Drain
B39	2"	Varies	Carbon Tank #4	Effluent from tank/Drain
B106	2"	N.C.	Alt. suction at discharge	For portable pump

Valve Schedule

Designation	Size	Normal Position	Location	Purpose
Globe Valves				
F3	2"	N.C.	MMF	Effluent from MMF - open during backwash
G-1	2"	N.O.	Upstream of MMF	Regulate flow rate
G-2	2"	N.C.	Parallel installation with G-1	Regulate flow rate when MMF bypassed
G-3	2"	N.C.	Discharge of Pump P4	Regulate carbon tank backwash influent
G-6	1"	N.O.	At backwash reinjection	Regulate flow from Pump P5 during reinjection
Gate Valves				
F1	2"	N.O.	MMF	Influent to MMF - closed during backwash
F2	2"	N.O.	MMF	Effluent from MMF, Influent from backwash pump P4
F4	1"	N.C.	MMF	Filter drain
F5	3/4"	N.C.	Cartridge filter	Filter drain

Initial Startup Valve Positions

Valve	Open	Closed
Ball Valves		
B1	✓	
B2	✓	
B3	✓	
B4	✓	
B6		✓
B7		✓
B11		✓
B13	✓	
B14	✓	
B15	✓	
B16	✓	
B17		✓
B19		✓
B20		✓
B21	✓	
B22		✓
B23		✓
B24		✓
B25		✓
B26	✓	
B27		✓
B27A		✓
B28	Varies	
B29	Varies	
B30	Varies	
B31	Varies	
B32		✓
B33		✓
B34		✓
B35		✓
B36	Varies	
B37	Varies	
B38	Varies	
B39	Varies	
B106		✓

Valve	Open	Closed
Globe Valves		
G1	✓	
G2		✓
F3		✓
G3		✓
G6	✓	

Gate Valves		
F1	✓	
F2	✓	
F4		✓
F5		✓

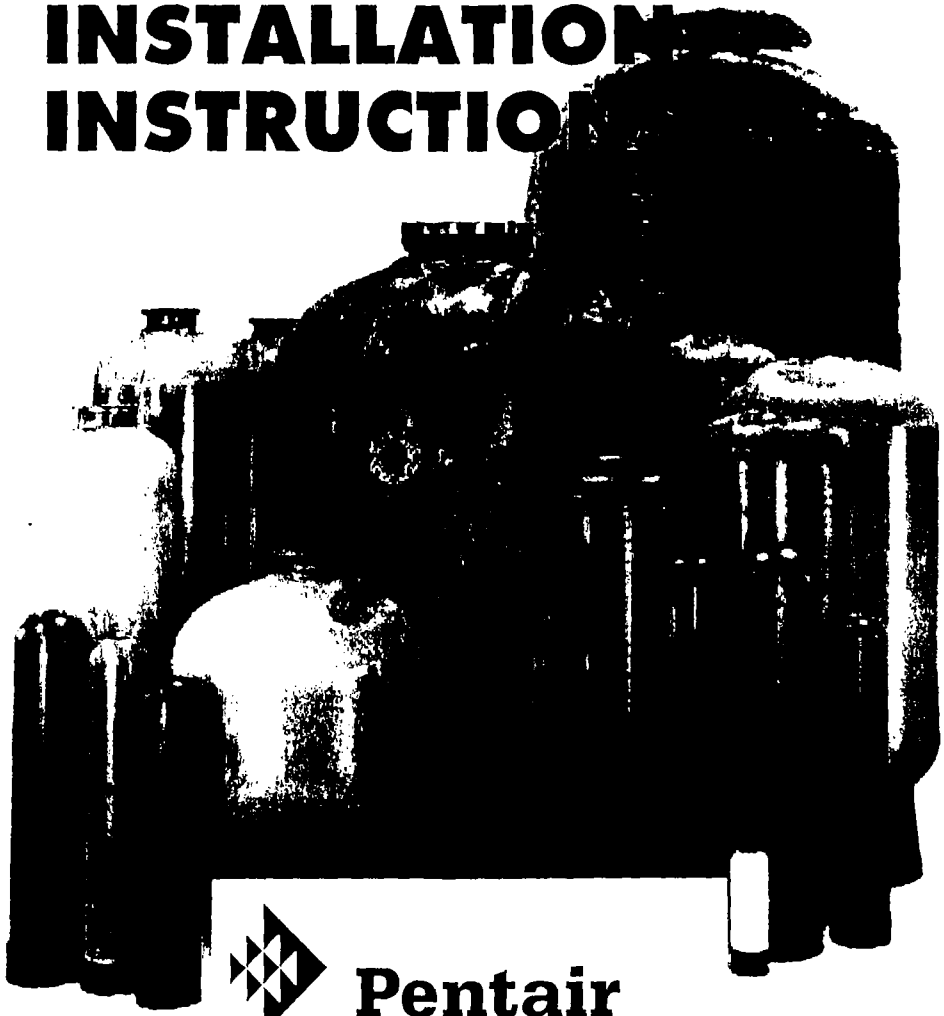
Appendix E

Equipment Manufacturer's Information

Pentair Carbon Vessels
Watts FS20 Flow Switch
George Fischer Electrical Actuator EA20
Data Industrial Series 1000 Flow Monitor
Campbell Scientific Model 107 Temperature Probe
Harmsco Hurricane Filter
W.E. Anderson H3 Differential Pressure Switch
Druck, Inc. Pressure Transducer & Junction Box
Data Industrial Series 228 Flow Sensor
Omega PX612 Pressure Transducer
BW Controls Wire Suspension Electrodes

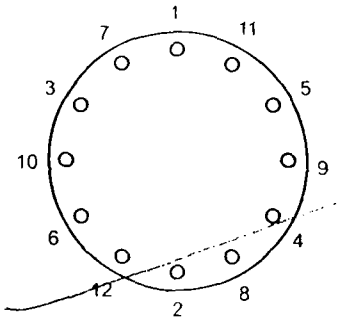
Separate volume:
Campbell Scientific Data Logger

PRESSURE VESSEL LIFTING, HANDLING & INSTALLATION INSTRUCTIONS

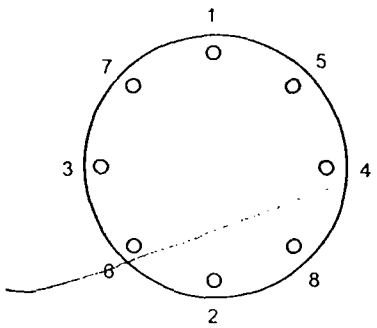


Pentair
Water Treatment

FLANGE COVER ASSEMBLY AND TORQUE RATINGS

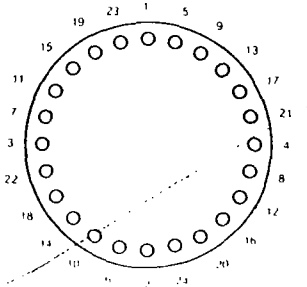


12-bolt Flange Cover (6", 152 mm Flange)
Tightening Sequence for 5/16" (7.9 mm)
Stainless Steel Bolts
Torque to 11 ft.-lbs. (15 NM)



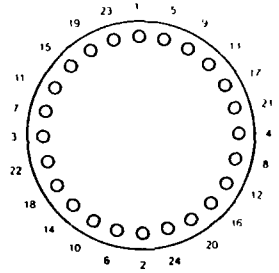
8-bolt Flange Cover (4-1/2", 114 mm Flange)
Tightening Sequence for 3/4" (19 mm)
Stainless Steel Bolts
Torque to 130 ft.-lbs. (176 NM)

For 24" Diameter Vessels

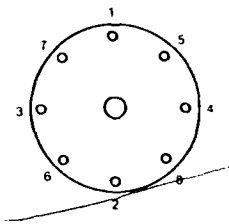


24-bolt Manway Flange Cover
24" (610 mm) Dia. Presure Vessels
Tightening Sequence for 3/8" (9.5 mm)
Stainless Steel Bolts
Torque to 18 ft.-lbs. (24 NM)

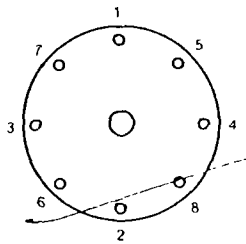
For All Vessels Larger than 24" Diameter



24-bolt Manway Flange Cover
Tightening Sequence for 1/2" (12.7 mm)
Stainless Steel Bolts
Torque to 45 ft.-lbs. (61 NM)



8-bolt, 4" (102 mm) ANSI Flange
Tightening Sequence for 5/8" (15.9 mm)
Stainless Steel Bolts
Torque to 90 ft.-lbs. (122 NM)



8-bolt, 6" (152 mm) ANSI Flange
Tightening Sequence for 3/4" (19 mm)
Stainless Steel Bolts
Torque to 130 ft.-lbs. (176 NM)

TORQUE CHART

5/16" (7.9 mm) s/s* bolts = 11 ft. lbs. (15 NM)
3/8" (9.5 mm) s/s* bolts = 18 ft. lbs. (24 NM)
1/2" (12.7 mm) s/s* bolts = 45 ft lbs. (61 NM)
5/8" (15.9 mm) s/s* bolts = 90 ft lbs. (122 NM)
3/4" (19 mm) s/s* bolts = 130 ft. lbs (176 NM)

* Stainless Steel

Composite Vessels

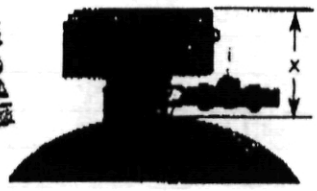
	Part No.	Description	Height w/ base Inches / mm	Height w/o base Inches / mm	Capacity Gallons / Liters	Cubic Feet	Top Open	Bottom Open	Top Side	Bottom Side	Base	Ship Weight
48" Diameter	31281	48 x 72	92.1 / 2339	76.0 / 1930	463 / 1753	61.9	6" FLG	N/A	N/A	N/A	tripod	780
	31285	48 x 72	92.1 / 2339	77.0 / 1955	463 / 1753	61.9	6" FLG	6" FLG	N/A	N/A	tripod	780
	31647	48 x 72	93.8 / 2383	78.0 / 1981	463 / 1753	61.9	16" MWY	6" FLG	N/A	N/A	tripod	780
	31283	48 x 72	96.1 / 2441	80.8 / 2052	463 / 1753	61.9	6" FLG	6" FLG	4" FLG	4" FLG	tripod	780
	31432	48 x 72	97.5 / 2477	81.7 / 2075	463 / 1753	61.9	16" MWY	6" FLG	4" FLG	4" FLG	tripod	780
63" Diameter	31390	63 x 67	79.5 / 2324	67.0 / 1702	600 / 2271	80.2	6" FLG	6" FLG	N/A	N/A	tripod	900
	Call Factory	63 x 67	79.5 / 2324	67.0 / 1702	600 / 2271	80.2	10" FLG	6" FLG	N/A	N/A	tripod	*
	31290	63 x 67	80.3 / 2344	67.8 / 1722	600 / 2271	80.2	16" MWY	6" FLG	N/A	N/A	tripod	900
	32008	63 x 67	80.3 / 2344	67.8 / 1722	600 / 2271	80.2	16" MWY	10" FLG	N/A	N/A	tripod	900
	31326	63 x 86	96.6 / 2758	84.1 / 2136	850 / 3218	114	6" FLG	6" FLG	N/A	N/A	tripod	1425
	32678	63 x 86	96.6 / 2758	84.1 / 2136	850 / 3218	114	6" FLG	6" FLG	4" FLG	4" FLG	tripod	1425
	32253	63 x 86	96.6 / 2758	84.1 / 2136	850 / 3218	114	10" FLG	6" FLG	N/A	N/A	tripod	1200
	31327	63 x 86	97.0 / 2769	84.5 / 2146	850 / 3218	114	16" MWY	6" FLG	N/A	N/A	tripod	1200
	31292	63 x 86	97.0 / 2769	84.5 / 2146	850 / 3218	114	16" MWY	6" FLG	4" FLG	4" FLG	tripod	1425
	32356	63 x 86	97.0 / 2769	84.5 / 2146	850 / 3218	114	16" MWY	10" FLG	N/A	N/A	tripod	1425
	32500	63 x 116	128.5 / 3264	116.0 / 2946	1250 / 4732	167	16" MWY	6" FLG	N/A	N/A	tripod	1425
	31325	63 x 116	128.5 / 3264	116.0 / 2946	1250 / 4732	167	16" MWY	6" FLG	4" FLG	4" FLG	tripod	1775
	Call Factory	63 x 116	128.5 / 3264	116.0 / 2946	1250 / 4732	167	16" MWY	10" FLG	N/A	N/A	tripod	*
	31456	63 x 144	158.5 / 4026	146.0 / 3708	1600 / 6057	214	16" MWY	6" FLG	N/A	N/A	tripod	2025
	31607	63 x 144	158.5 / 4026	146.0 / 3708	1600 / 6057	214	16" MWY	6" FLG	4" FLG	4" FLG	tripod	2025
	31684	63 x 144	158.5 / 4026	146.0 / 3708	1600 / 6057	214	16" MWY	10" FLG	N/A	N/A	tripod	2025

*Measurements are subject to change without notice and are for reference only.

Color Options: AL - Almond BL - Blue BK - Black GR - Gray NA - Natural

NOTE: See flex connection and vacuum breaker information on page 13.

5 YEAR WARRANTY



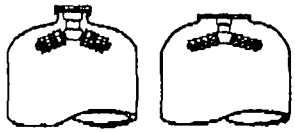
Installation Tips:
- Bolt base to floor
- Calculate height for valve and base combined (see photo)

Fleck Valve	Tank Dia. Inches / mm	Adder Ht. (X) Inches / mm
2750	18 / 457	6.5 / 165
2850	21 / 533	6.5 / 165
2900	24, 30 / 610, 762	12 / 305
2930	36 / 914	13 / 330
3150	42 / 1067	10 / 254
3900	48-63 / 1219-1600	15 /381

Top Mount Diffuser

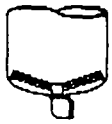
Diameter (Inches)	Top Open	Part No. Composite	Part No. FRP	System Connection	Flow Rate (GPM)
18-48	6" FLG	5679	N/A	3" FNPT	88
21-36	6"-8"	N/A	5700	3" FNPT	88

Top Mount High Flow Hub and Lateral



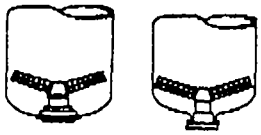
Diameter (Inches)	Top Open	Part No. Composite	System Connection	Flow Rate (GPM)
21-63	6" FLG	5680	3" FNPT	200
42-63	16" MWY	10877	3" FNPT	200

Bottom Mount Hub and Lateral



Diameter (Inches)	Bottom Open	Part No. Composite	Part No. FRP	System Connection	Flow Rate (GPM)
18	4"-8"	5669	N/A	2" Slip	100
21	4"-8"	5669	5668	2" Slip	100
24	4"-8"	5670	5669	2" Slip	100
30	4"-8"	11039	N/A	2" Slip	100
36	4"-8"	11040	N/A	2" Slip	100

Bottom Mount Hub and Lateral



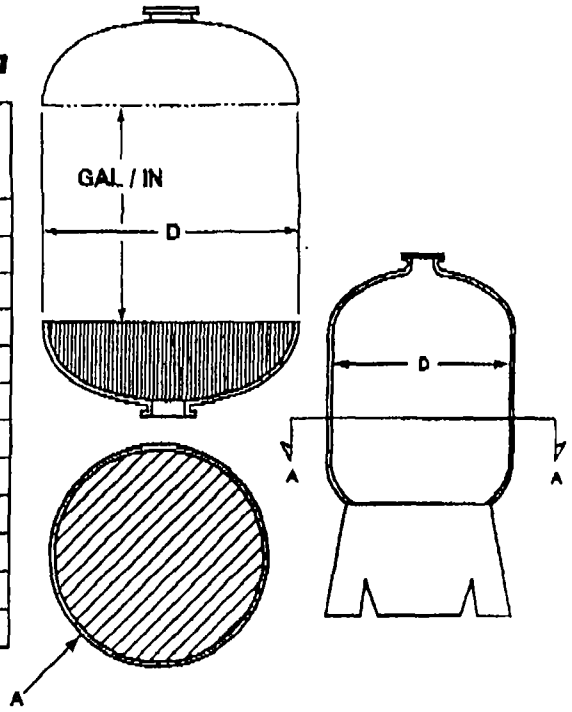
Diameter (Inches)	Bottom Open	Part No. Composite	Part No. FRP	System Connection	Flow Rate (GPM)
18	6" FLG	11790	N/A	3" FNPT	122
21	6"-8	N/A	5696	3" FNPT	122
21	6" FLG	5678	N/A	3" FNPT	122
24	6"-8	N/A	5697	3" FNPT	122
24	6" FLG	5678	N/A	3" FNPT	122
30	6"-8	N/A	5698	3" FNPT	122
30	6" FLG	5683	N/A	3" FNPT	122
36	6"-8	N/A	5699	3" FNPT	122
36	6" FLG	5684	N/A	3" FNPT	122
42	6" FLG	5686	N/A	3" FNPT	122
48	6" FLG	5686	N/A	3" FNPT	122

Note: Flow rates calculated with a 5 psi pressure drop.

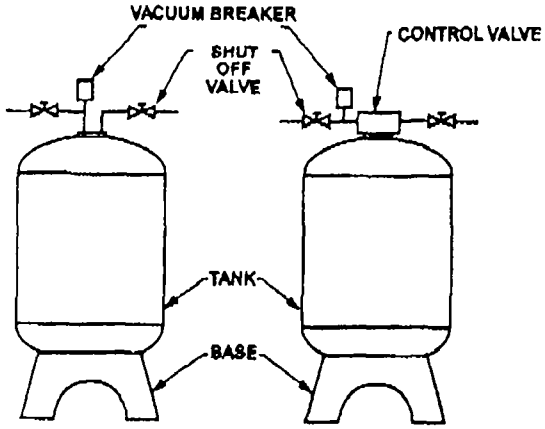
Dome Volume (gallons) and Straight Wall Gallon per Inch

Nominal Diameter D (inches)	Gallons* (One Dome)	Gallon / Inch (Approx.)	A (Sq. Feet)
12	1.0	0.5	0.7
13	1.4	0.5	0.9
14	1.7	0.6	1.1
16	2.7	0.8	1.3
18	3.7	1.0	1.8
21	6.2	1.4	2.4
24	9.3	1.9	3.0
30	18	2.9	4.6
36	33	4.2	6.7
42	52	5.7	9.0
48	74	7.5	12.0
63	168	13.0	20.0

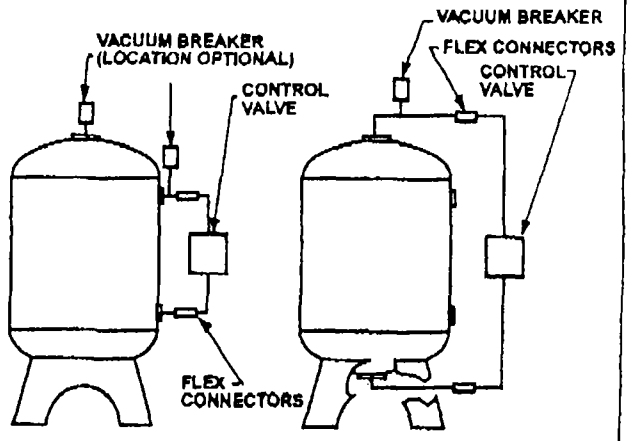
*Cubic Ft. = 0.1337 x Gallons



Vacuum Breaker Installation

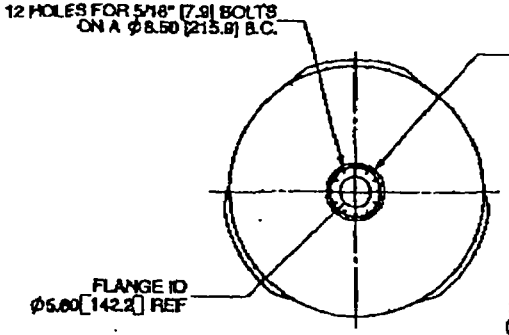


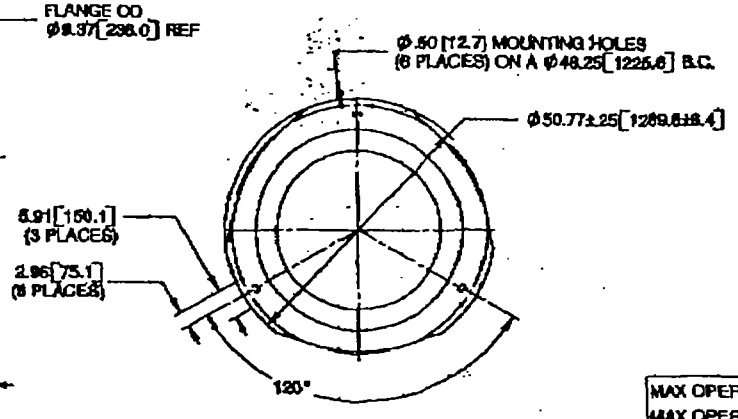
Flex Connectors Installation

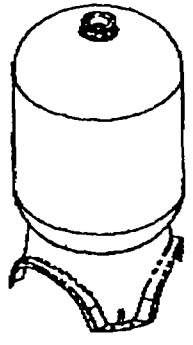


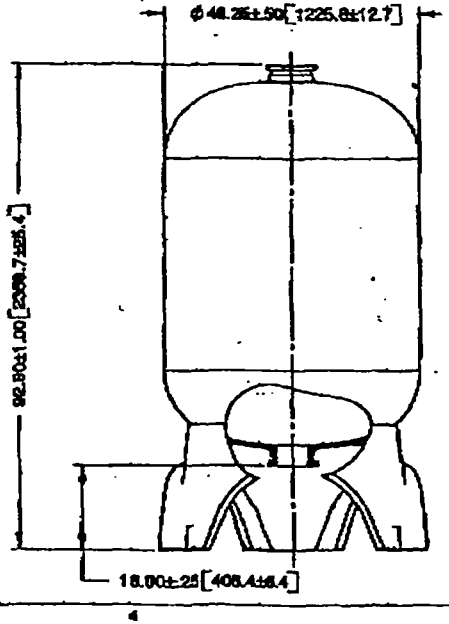
NOTE: Flexible connectors must be installed between hard piping and tank openings. These pressure vessels are rated for an internal negative pressure of 5" HG (17 Pa) vacuum below atmospheric. If negative pressure could ever exceed 5" Hg (17 Pa), an adequate vacuum breaker must also be properly installed. Failure to install flex connection properly, or improper installation of a vacuum breaker when required, may void the warranty.

REVISIONS					
ZONE	ECN	REV.	DESCRIPTION	DATE	APP'D
		A	FIRST RELEASE	11/29/05	RLD

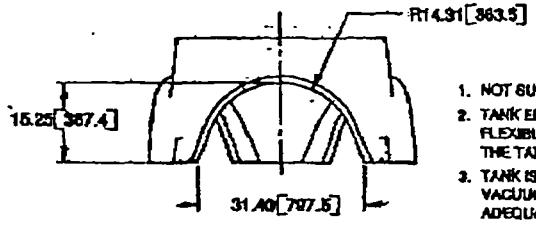








TRIPOD BASE DETAIL



MAX OPERATING PRESSURE	150 PSIG	[1034 kPA]
MAX OPERATING TEMPERATURE	150 °F	[66 °C]
TANK VOLUME	463 GAL	[1753 L]
DOME VOLUME	74 GAL	[280 L]
TANK WEIGHT WITH BASE	494 LBS	[224 Kg]

1. NOT SUITABLE FOR PNEUMATIC PRESSURE APPLICATIONS.
2. TANK ELONGATES UP TO .25 [6.4mm] AT MAXIMUM OPERATING PRESSURE. FLEXIBLE CONNECTIONS ARE RECOMMENDED TO PREVENT DAMAGE TO THE TANK OR PIPING.
3. TANK IS RATED FOR AN INTERNAL NEGATIVE PRESSURE OF 5.0 In Hg VACUUM. HIGHER VACUUM VALUES MUST BE PREVENTED WITH AN ADEQUATE VACUUM BREAKER.
4. MINIMUM CLEARANCE OF 48.0 [1219.2] ON TOP REQUIRED FOR PIPING AND MANEUVERING.

LAST SAVED IN SMARTEAM: 11/29/2005 14:38

CRITICALITY SYMBOLS PER QPSP-604.2
☐ LEVEL I ■ LEVEL II ■ LEVEL III

DO NOT SCALE DRAWING. WHEN ARE IN INCHES [mm]
INTERPRET [mm] AND TOLERANCES PER ASME Y14.5M-1994 UNLESS OTHERWISE SPECIFIED.
SURFACE FINISH REMOVE ALL [63 µm]
TOLERANCES:
ANGLES ± 1°
2 PLACE ± .X = .05
3 PLACE ± .XX = .01
4 PLACE ± .XXX = .005

PARTS LIST

THIS DRAWING MUST BE COMPARED TO THE ERP SYSTEM TO ENSURE CORRECT REVISION LEVEL PRIOR TO USE.

THIRD ANGLE PROJECTION

APPROVALS		DATE
DRAWN	mll	11/30/2005
CHECKED	RLD	11/29/05
APPROVED		

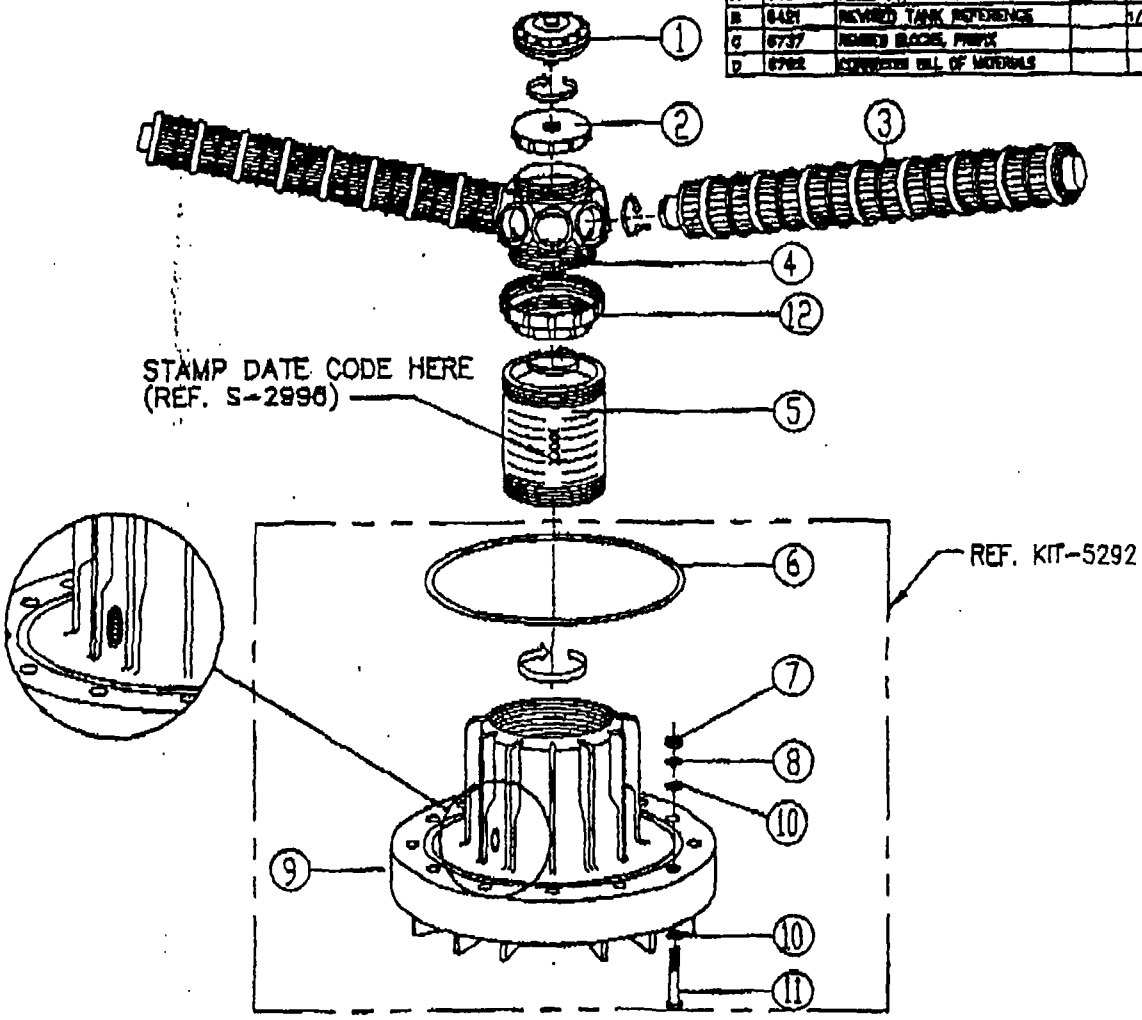
Pentair Water Treatment
5500 PARK DRIVE CHANDLER, OH 44024 USA

TITLE: 48X72 TANK WITH TRIPOD BASE 6" SNA TOP & BOTTOM FLANGE

SIZE	DWG NO.	REV
B	CHSK-5055	A

SCALE 1:20 SOLIDWORKS FORMAT SHEET 1 OF 1

REVISIONS				
LTR.	ECN NO.	DESCRIPTION	APP'D.	DATE
A	6404	RELEASED TO PRODUCTION		12/1/93
B	6481	REVISED TANK REFERENCE		1/11/94
C	6737	ADDED BLOCK, PRINT		
D	6962	CORRECTED BILL OF MATERIALS		



ITEM	QTY.	PART NO.	NAME and DESCRIPTION
14	1	5279	CARTON 17 1/4" x 11 1/4" x 10"
13	1	5814	INSTRUCTIONS
12	1	5730	ADAPTER
11	12	4750-1	BOLT
10	24	4750-4	WASHER
9	1	4735-25	ADAPTER
8	12	4750-3	WASHER
7	12	4750-2	NUT
6	1	2694-69	O-RING
5	1	5083	PIPE (CPVC)
4	1	5724	HUB (ABS)
3	8	5488	LATERAL
2	1	5733	ADAPTER
1	1	5732	CAP LATERAL

BILL OF MATERIALS

STRUCTURAL NORTH AMERICA
INDUSTRIAL PKWY
110 PARK DRIVE
CHARDON, OHIO
An ESSEF Company

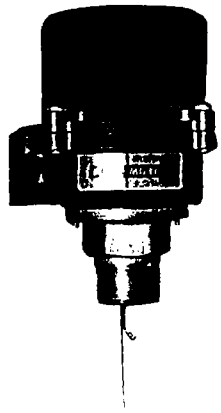
TITLE
BOTTOM MOUNT HUB AND LATERAL SYSTEM ASSEMBLY for 42" -48" FLANGED COMPOSITE TANKS

DRAWN	SS	05/09/95	DWG. SIZE: A	SCALE: NONE
CHECKED			DRAWING NUMBER: 5686	DWG. REV.: D
PROJ. ENG.	JM			
DIR of ENG	JM		SHEET 1 OF 1	

WATTS FS20 Nema 4X Type FLOW SWITCH

• Corrosion-resistant • Epoxy coated • Zinc die-cast enclosure

Provides accurate monitoring of flow in pipelines servicing water systems. Recommended for use in areas of high humidity for indoor or outdoor installations requiring Nema 4X water-tight, dust-tight and corrosion-resistant enclosures. The FS20 flow switch is primarily designed to be used as an automatic control or safety device. The single pole, double-throw switch can be wired to start or stop a motor when a ***flow*** or ***no flow*** condition exists or actuate an alarm when flow is inadequate. Turns off alarm when adequate flow is restored.



TYPICAL USES

Signal devices – for flow or no flow

Control of motors – for pumps, compressors, etc.

Alarms – warn of trouble where flow failure is critical

Heating Units – to start or stop a heat source

Metering Devices – to control equipment that supplies additives for blending

TYPICAL APPLICATIONS

- Air Conditioning
- Water Treatment
- Liquid Transfer Systems
- Additive/Blending Systems
- Water Cooled Equipment
- Pumping Systems
- Hot Water Supply Systems
- Hot Water Space Heating
- Processing Systems

SPECIFICATIONS

Canadian Standards Assoc. Listed No. LR-5827

Underwriter's Laboratories Listed U.S.A. No. 11S1

Maximum Pressure: 150psi

Maximum Temperature: 300°F

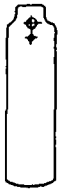
Shipping Weight: 3 lbs.

1" NPT connection.

PADDLES

3 in 1 Paddle – A segmented beryllium copper paddle is quickly adaptable for 1" through 3" pipe. The extended beryllium copper paddle, also included, is for larger pipe sizes up to 6".

Paddle length conforms to ASTM tee standards.



Replacement Kit Number	Description
RK FS10-3-1	3-in-1 Paddle
RK FS10-6	6" Paddle
RK PRP-218-3957	O-Ring
RK PRP-124	O-Ring
RK PRP-152	O-Ring

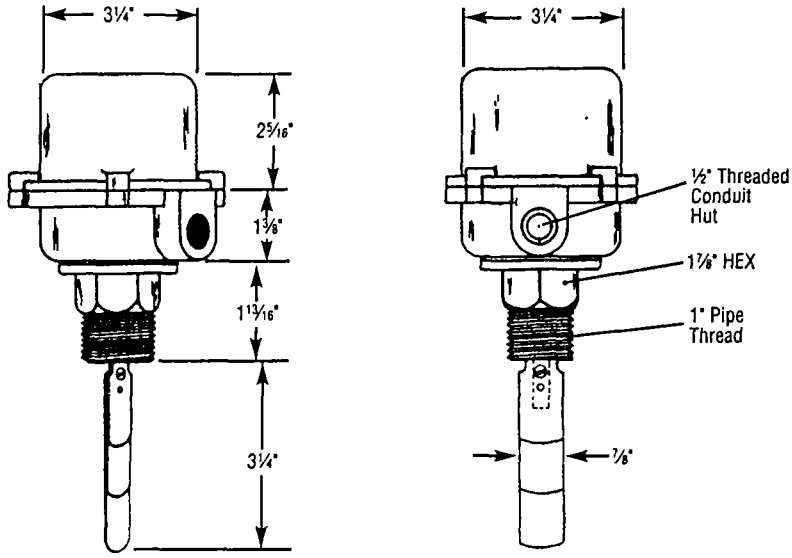
TYPICAL CONDITIONS

- Equipment splashing water
- Seepage of water
- Leakage of hose directed water
- Severe general condensation
- Windblown dust and water
- Sleet or icy conditions

FEATURES

- Parts in contact with liquid in pipe are of *brass* and *beryllium* copper.
- Brass alloy bellows seals switch assembly from the line.
- Two adjusting screws (fine and course) provides easy way to adjust sensitivity to flow.
- ½" threaded conduit hub to accept standard vapor-proof connectors
- Removable cover for easy access to switch terminals where wiring will not interfere with operation mechanism.
- Cover construction of zinc die-cast with epoxy coated finish.
- Furnished with 1" NPT connection.
- Switch assembly independent and removable from mounting adaptor, allows proper paddle orientation, avoiding improper operation.
- Canadian Standards Association listed.
- Underwriter's Laboratories Inc. listed.

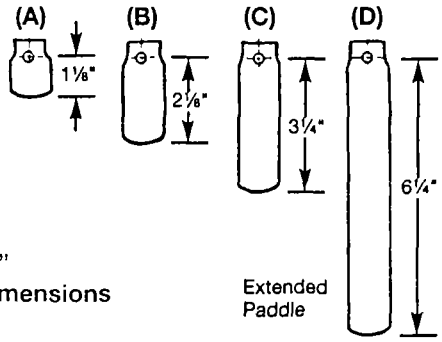
DIMENSIONS



PADDLE LENGTH

Included with each flow switch are four paddles. Shortest paddle (A) can be used for 1" pipe size only. Second shortest paddle (B) can be used as is for 2" pipe size; but can be trimmed for 1¼" and 1½" pipe size. Third shortest paddle (C) can be used as is for 3" pipe size, but must be trimmed for 2½" pipe size. Longest paddle (D) can be used as is for 6" pipe size, but must be trimmed for 4" and 5" pipe size.

The "L" dimensions below refer to the untrimmed paddle lengths.

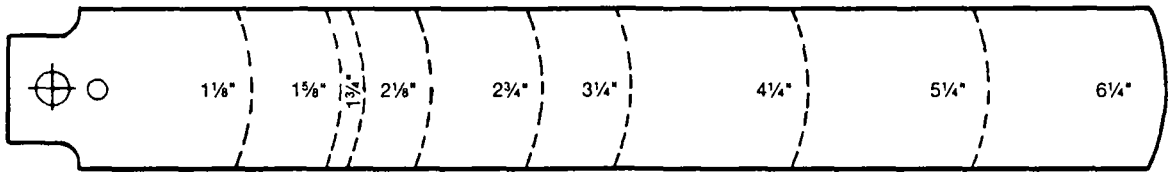


"L" Dimensions

Extended Paddle

See Paddle Length Selection Table on page 6.

ACTUAL SIZE PADDLE TEMPLATE For Trimming



*IMPORTANT:

Mount flow switch in position so that the paddle assembly is at a right angle to the flow. The stamped arrow on bottom plate mounting and top cover gum label arrow must both point in direction of flow. (See page 6 for "Installation" and page 7 for "Flow rates and wiring information.")

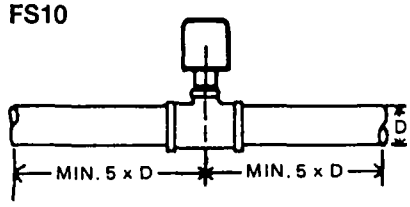
PADDLE LENGTH SELECTION

Included with each flow switch are four paddles; a 3 in 1 paddle and an extended paddle. Refer to the paddle length selection table below for correct paddle length in relation to the pipe size being used.

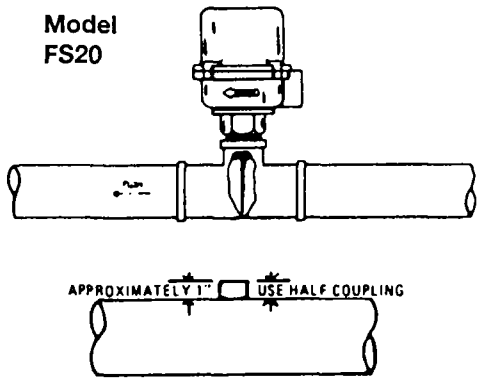
PADDLE LENGTH SELECTION TABLE

Pipe Size	Installation Using ASTM Tee		Installation Using Welding Fitting	Trim Dimension
	Tee Size	Paddle	Paddle	L
1"	1" x 1" x 1"	1" A Segment		
1¼"	1¼" x 1¼" x 1"	1" A Segment & Trimmed 2" B Segment		1⅜"
1½"	1½" x 1½" x 1"	1" A Segment & Trimmed 2" B Segment		1¾"
2"	2" x 1" x 1"	1" A Segment & 2" B Segment	1" A Segment & 2" B Segment	
2½"	2½" x 2½" x 2"	1" A & 2" B Segments & Trimmed 3" Segments	1" A & 2" B Segments & Trimmed 3" C Segments	2¾"
3"	3" x 3" x 1"	1" A, 2" B, 3" C Segments	1" A, 2" B & 3" C Segments	
4"			1" A, 2" B, 3" C & Trimmed 4" D Segments	4¼"
5"			1" A, 2" B, 3" C & Trimmed 4" D Segments	5¼"
6"			1" A, 2" B, 3" C & Trimmed 4" D Segments	

Model FS10



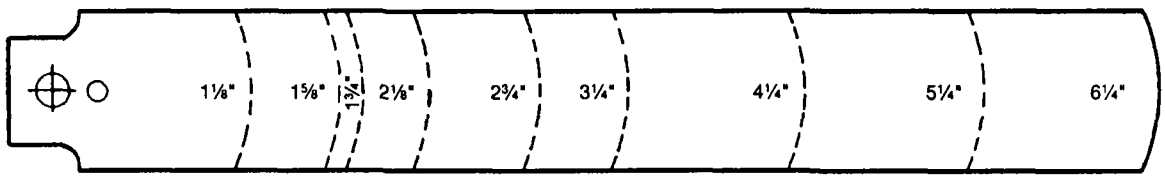
Model FS20



If a reducing tee is not available and a standard tee is used, install a face bushing in top opening to keep waterflow indicator as close to tee as possible.

If a welding fitting is to be used, use only a half coupling. (Make sure hole in main is 1 $^{3}/_{32}$" diameter before welding coupling.)

ACTUAL SIZE PADDLE TEMPLATE For FS10C or FS20.



FLOW RATES

FLOW RATES Required to Actuate the No. FS10C or FS20 Flow Switch in Horizontal Pipe

Flow rates in U.S. gallons per minute (GPM). Velocity in feet per second (FPS).

*Equipped with extended paddle trimmed to pipe size.

Pipe Size in Which Flow Switch Installed			1"	1¼"	1½"	2"	2½"	3"	4"	5"	6"
Factory or Minimum Flow Setting	ACTIVATION FLOW	GPM	5.2	7.9	10.0	13.2	20.9	30.0	39.0	58.0	79.0
		FPS	2.01	1.74	1.62	1.29	.92	1.30	1.0	.94	.88
	DEACTIVATION NO FLOW	GPM	2.0	3.2	5.3	8.1	9.9	12.0	19.0	29.0	39.6
		FPS	.77	.71	.86	.79	.44	.52	.50	.47	.44
Maximum Flow Setting	ACTIVATION FLOW	GPM	11.5	18.0	18.0	34.1	53.9	52.0	73.5	115.0	166.0
		FPS	4.44	3.98	2.91	3.33	2.38	2.26	1.86	1.85	1.84
	DEACTIVATION NO FLOW	GPM	8.5	14.6	15.1	29.2	44.4	46.1	64.0	92.0	123.0
		FPS	3.28	3.23	2.44	2.85	1.96	2.00	1.67	1.48	1.37

*Flow rates for these sizes are calculated.

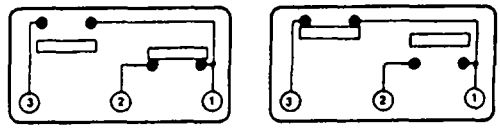
WIRING

IMPORTANT: Electrical installation must be performed by a qualified person and in accordance with local codes.

Electrical Rating

Motor Duty Full Load Locked Rotor	120 V.A.C. 7.4 A.F.L. 44.4 A.F.L.	240 V.A.C. 3.7 A.F.L. 22.2 A.F.L.
	120 V.D.C. 0.3 Amps	240 V.D.C. 0.15 Amps
PILOT DUTY: A.C. 125 V.A., 120-240 V		

Schematics of No. FS10C or FS20 Operation



FLOW NO FLOW

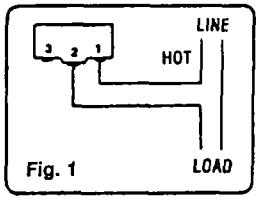


Fig. 1

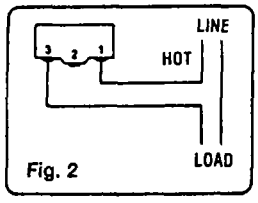
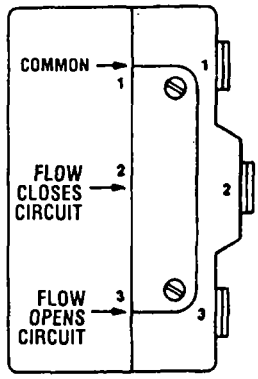


Fig. 2



1. Flow switch used to sound alarm, light signal, actuate relays or starter switches for motors, pumps, etc., when flow occurs.
2. Flow Switch used to sound alarm, light signal, actuate relays or starter switches for motors, pumps, etc., when no flow occurs.

INSTALLATION INSTRUCTION - WATTS TYPE NEMA 4X FS20 FLOW SWITCH

GENERAL APPLICATION: For indoors and outdoors installation of high humidity requiring watertight, dusttight and corrosion resistant enclosures.

TYPICAL CONDITIONS: - Equipment splashing water - Leakage or hose directed water - Wind blown dust and water
- Seepage of water - Severe general condensation - Sleet or icy conditions

IMPORTANT: *Electrical installation must be performed by a qualified person and in accordance with all local codes.*

LOCATION: Flow switch should be installed in horizontal or vertical section of a pipe or tube where there is a straight run of at least 5 pipe diameters on each side.

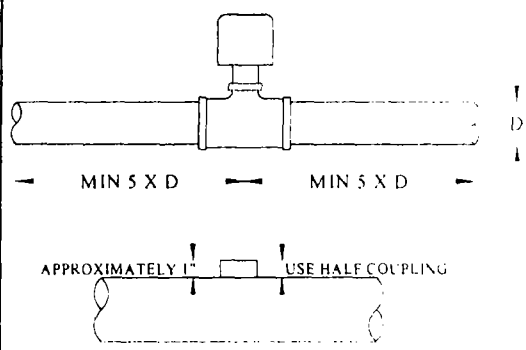
MOUNTING: Flow switch should be installed vertically upright in tees or welded fittings.

ELECTRICAL INSTALLATION: Watertight and dusttight installations require the use of rigid galvanized metal conduit and fittings. Temperature exceeding 180°F requires electrical wiring insulation rated at 75°C or 167°F. Select required mode of operation and electrical wire in accordance with appropriate diagram (Fig. 1 or 2). Cover flange screws should be torqued to approximately 30-40 inch pound. Following mechanical and electrical installation, test flow switch for desired operation.

VERTICAL PIPE INSTALLATIONS: Flow rates for vertical installations are not available. However, the FS20 generally operates satisfactorily when installed in a vertical pipe with either upward or downward flow provided there is no amount of dirt or sediment in the water. In order to confirm satisfactory operation, it is advisable to hold the FS20 in position to be installed and manually check for "no flow" switch operation (by hand operation of the paddle).

PIPE SIZE	INSTALLATION USING ASTM TEE		INSTALLATION USING WELDED FITTING PADDLE	TRIMMED DIMENSION "L"
	TEE SIZE	PADDLE		
1"	1" x 1" x 1"	1"A Segment		
1-1/4"	1-1/4" x 1-1/4" x 1"	1"A Segment & Trimmed 2"B Segment		1-5/8"
1-1/2"	1-1/2" x 1-1/2" x 1"	1"A Segment & Trimmed 2"B Segment		1-3/4"
2"	2" x 2" x 1"	1"A Segment & 2"B Segment	1"A Segment & 2"B Segment	
2-1/2"	2-1/2" x 2-1/2" x 1"	1"A & 2"B Segments & Trimmed 3"C Segments	1"A & 2"B Segments & Trimmed 3"C Segments	2-3/4"
3"	3" x 3" x 1"	1"A, 2"B, & 3"C Segments	1"A, 2"B, & 3"C Segments	
4"			1"A, 2"B, 3"C, and Trimmed 4"D Segments	4-1/4"
5"			1"A, 2"B, 3"C, and Trimmed 4"D Segments	5-1/4"
6"			1"A, 2"B, 3"C, 4"D Segments	

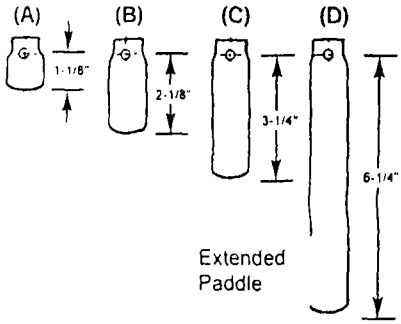
"L" refers to trim length in table.



If a reducing tee is not available and a standard tee is used, install a face bushing in top opening to keep waterflow indicator as close to tee as possible.

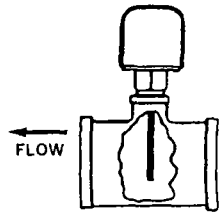
If a welded fitting is to be used, use only a half coupling. (Make sure hole in main is 1-5/32" dia. before welding coupling.)

PADDLE LENGTH: Included with each flow switch are four paddles. Shortest paddle (A) can be used for 1" pipe size only. Second shortest paddle (B) can be used as is with paddle (A) for 2" pipe size; but must be trimmed for 1-1/4" and 1-1/2" pipe size. Third shortest paddle (C) can be used as is with paddle (A) and (B) for 3" pipe size, but must be trimmed for 2-1/2" pipe size. Longest paddle (D) can be used as is with paddle (A), (B) and (C) for 6" pipe size, but must be trimmed for 4" and 5" pipe size.



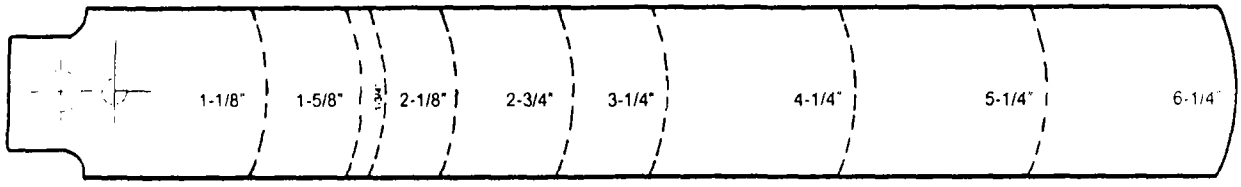
NOTE: PADDLE LENGTH CONFORMS TO ASTM TEE STANDARD.

USE TEMPLATE BELOW TO TRIM PADDLE TO REQUIRED LENGTH "L".



Always check operation of flow switch to make sure paddle is free to move in the tee, coupling or pipe before finishing the installation.

ACTUAL SIZE TEMPLATE TO TRIM DIMENSION "L"



IMPORTANT:

Mount flow switch in position so that the paddle assembly is at a right angle to the flow. The stamped arrow on bottom plate mounting and label arrow on body must both point in direction of flow.

- UNDERWRITER'S LABORATORY LISTED
- CANADIAN STANDARD'S ASSOCIATION LISTED
- MAXIMUM PRESSURE 175 PSI
- MAXIMUM TEMPERATURE 300°F

IS-FS20
EDP# 5003207 rev 2

FLOW RATES REQUIRED TO ACTUATE No. FS20 FLOW SWITCH IN HORIZONTAL PIPE

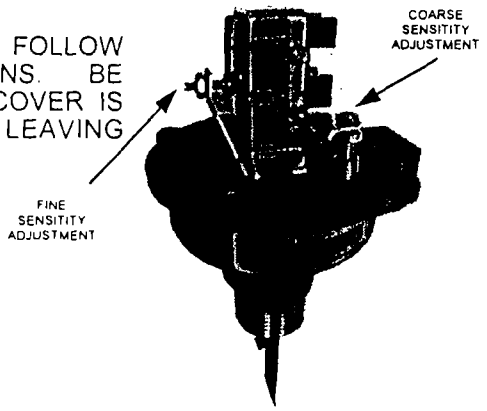
Flow rates in U.S. gallons per minute (GPM). Velocity in feet per second (FPS).
*Equipped with extended paddle trimmed to pipe size

Pipe Size in Which Flow Switch Installed			1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	*4"	*5"	*6"
Factory or Minimum Flow Setting	ACTIVATION FLOW	GPM	5.2	7.9	10.0	13.2	20.9	30.0	39.0	58 0	79 9
		FPS	2.01	1.74	1.62	1.29	0.92	1.30	1.0	0 94	0 88
	DEACTIVATION	GPM	2.0	3.2	5.3	8.1	9.9	12.0	19.0	29 0	39 6
		FPS	0.77	0.71	0.86	0.79	0.44	0.52	0.50	0.47	0.44
Maximum Flow Setting	ACTIVATION FLOW	GPM	11.5	18.0	18.0	34.1	53.9	52.0	73.5	115.0	166 0
		FPS	4.44	3.98	2.91	3.33	2.38	2.26	1.86	1.85	1.84
	DEACTIVATION	GPM	8.5	14.6	15.1	29.2	44.4	46.1	64.0	92.0	123.0
		FPS	3 28	3.23	2.44	2.85	1.96	2.00	1.67	1 48	1 37

*Flow rates for these sizes are calculated.

ADJUSTMENT

TO ADJUST SETTINGS, FOLLOW A OR B INSTRUCTIONS. BE SURE FLOW SWITCH COVER IS REPLACED BEFORE LEAVING JOB



A. FINE SENSITIVITY

1. REMOVE SWITCH COVER.
2. FOR FINER SENSITIVITY, TURN RANGE ADJUSTING SCREW CLOCKWISE. LOCATED ON LEVER NEXT TO MICROSWITCH.

B. COARSE SENSITIVITY

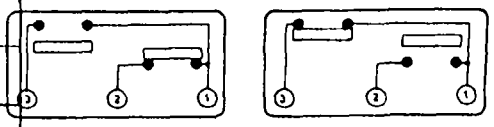
1. REMOVE SWITCH COVER.
2. FOR HIGHER FLOW RATE, TURN RANGE ADJUSTING SCREW CLOCKWISE. LOCATED WITH ADJUSTING SPRING.
3. FOR LOWER FLOW RATE, TURN COUNTER CLOCKWISE.

WIRING INSTRUCTIONS

Electrical Rating

Motor Duty Full Load Locked Rotor	120 V.A.C. 7.4 A.F.L. 44.4 A.F.L.	240 V.A.C. 3.7 A.F.L. 22.2 A.F.L.
	120 V.D.C. 0.3 Amps	240 V.D.C. 0.15 Amps
PILOT DUTY: A.C. 125 V.A., 120-240 V		

Schematics of No. FS20 Operation



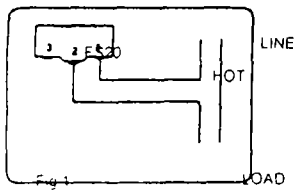


Fig 1

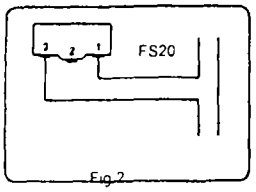


Fig 2

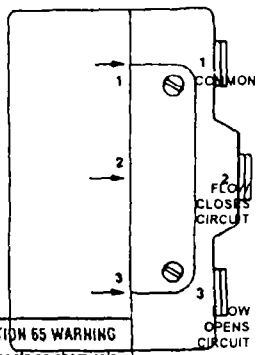


Fig 1 Flow switch used to sound alarm, light signal, actuate relays or starter switches for motors, pumps, etc, when flow occurs.

Fig 2 Flow switch used to sound alarm, light signal, actuate relays or starter switches for motors pumps etc, when no flow occurs

CALIFORNIA PROPOSITION 65 WARNING

WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm (California law requires this warning to be given to customers in the State of California)

For more information: www.wattsind.com/prop65

OPTIONS:
"L" Pilot Light
"BSP" British Threaded Body

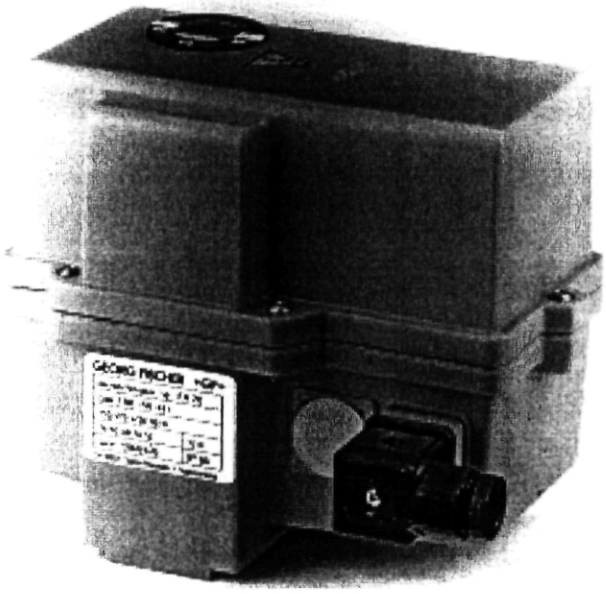
REPAIRS AND REPLACEMENT

PADDLES AND COVER MAY BE REPLACED IN THE FIELD. OTHER FIELD REPAIRS MUST NOT BE MADE. REPLACEMENT FLOW SWITCHES MAY BE OBTAINED FROM THE NEAREST WATTS DISTRIBUTOR OR WHOLESALER. WHEN ORDERING A REPLACEMENT SWITCH, SPECIFY PRODUCT NUMBER AS SHOWN ON THE FLOW SWITCH

REPLACEMENT KIT #	DESCRIPTION
RK FS10-3-1	PADDLE A, B & C
RK FS10-6	PADDLE D
RK PRP-218-3957	"O" RING
RK-PRP-124	"O" RING
RK-PRP-152	"O" RING

WATTS® REGULATOR
USA: 815 Chestnut St., North Andover, MA 01845-6098 www.wattsreg.com
CANADA: 5435 North Service Rd., Burlington, Ont. L7L 5H7 www.wattscanada.ca

Instruction Manual



Electrical Actuator Unit Type EA 20

GEORGE FISCHER +GF+

Table of Contents

1. Introduction

This instruction manual contains all the information regarding design, installation and start-up procedure for the electrical actuator unit Type EA 20.

Warnings:

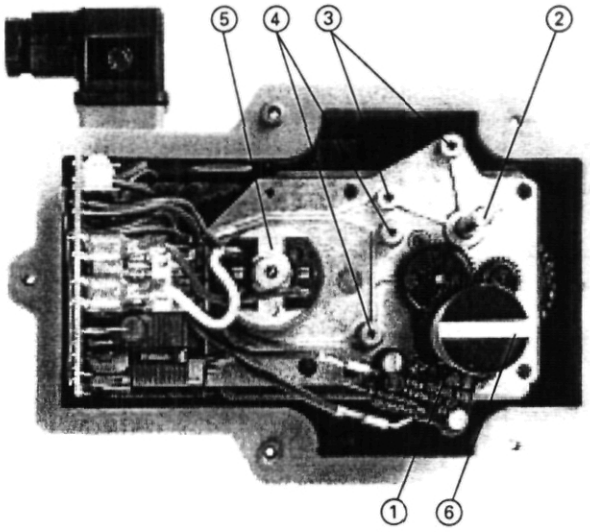
- Do not work on this unit before disconnecting it from the mains!
- The actuator is factory preset to a mains voltage of 230 V AC. By all means refer to Item 2.1.
- Electric actuators do not have a safety position. In case of a mains breakdown, the actuator resp. the valve remains in its actual position.
- Any work done on the actuator may only be carried out by authorized and trained personnel.
- These products are according to the Machine Guidelines 98/37/EG (ancient 89/392/EWG), not regarded as machines; they are, however, built into installations which are regarded as machines.

CE

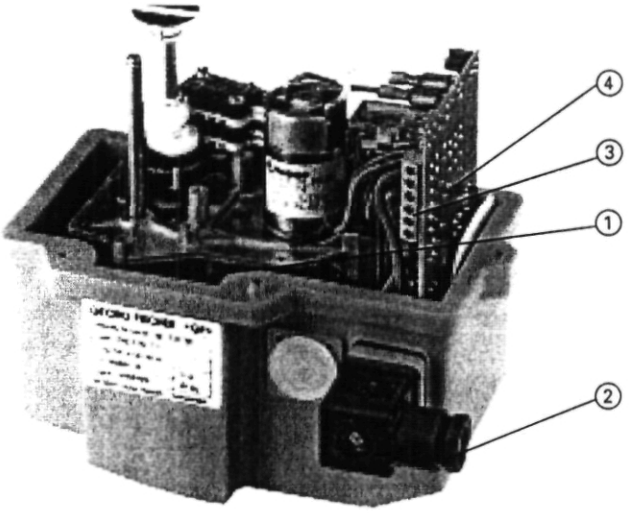
Note
We distinctly emphasize that operation is prohibited until it has been confirmed that the machine (plant) into which the products have been built corresponds to the conditions of the EC Machine Guidelines 98/37/EG (ancient 89/392/EWG).

2. Design of the actuator

The standard version of the electrical actuator EA 20 consists of the following elements: spur-wheel gear, DC motor, power supply board as well as components for limit positioning. For special applications, the actuator can be equipped with additional modular components (see Item 6).



1 Limit Switch S1 und S2
2 Spindle for additional switching cams
3 Mounting space for additional limit switches
4 Mounting space for potentiometer and/or operating time adjustment module
5 DC motor
6 Visual position indicator
↷ valve closes
↶ valve opens

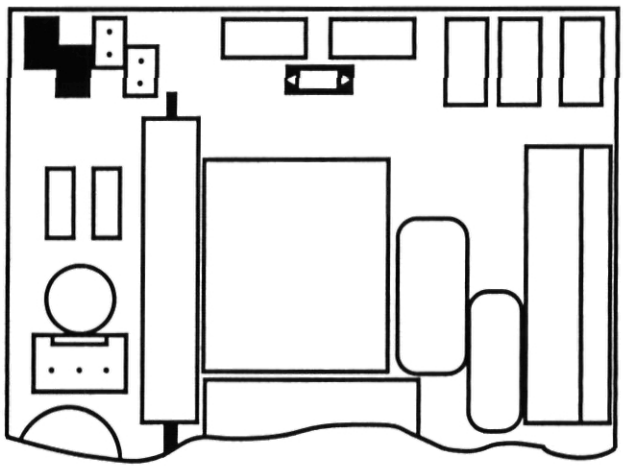


1 Spur-wheel gear
2 Unit plug
3 Connector terminal strip for external connections max. 1,5 mm²
4 Electrical supply unit

2.1 Mains Voltage Selection

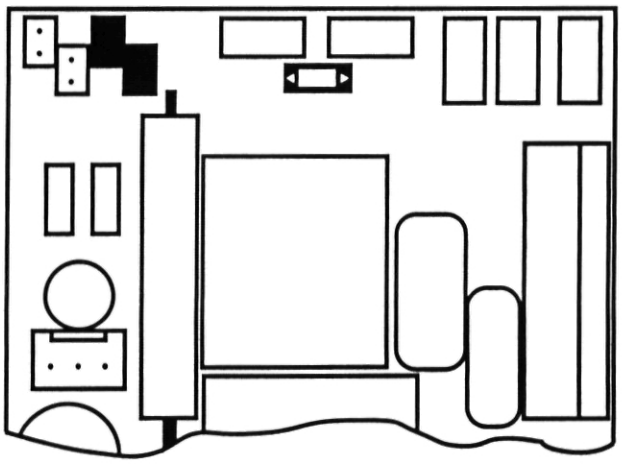
230 V, 50–60 Hz

The actuator is factory preset for 230 V ~



115 V, 50–60 Hz

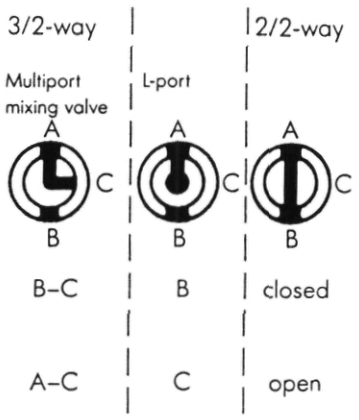
Selecting 115 V ~ can be done by changing the corresponding jumpers as shown in the diagram



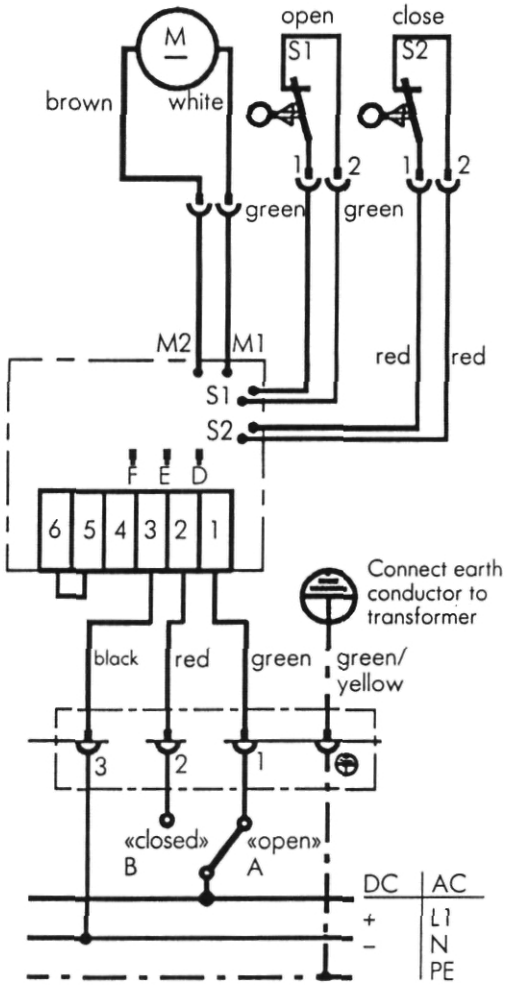
Do not work unit when under voltage!

2.2 Wiring Diagram Standard Version

Position indicator



As a component the electrical actuator unit EA 20 is delivered in position «open» (A–B)



Do not use S1 and S2 for electric position feedback.

3. Design of Actuated Valve

The electrical actuator Type EA 20 can be mounted on a valve via a suitable intermediate housing. The actuators are delivered ex factory in the «open» position. Pictured below under 3.1 and 3.2 are the assembly parts necessary for the automatic ball valve Type 111–113 and Type 115 from George Fischer. Both end positions are preset in the factory. It is necessary to readjust them after the customer has assembled the unit (see Item 4).

3.1 Ball valve Type 115

1. Type EA 20 Actuator unit

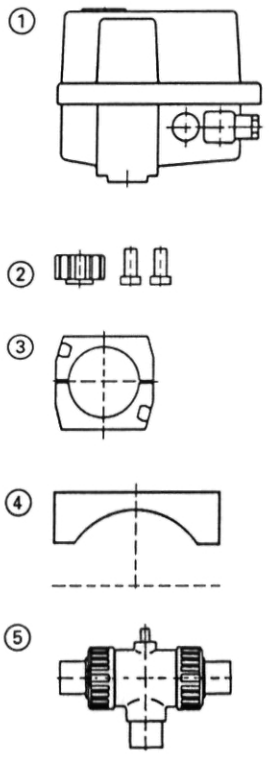
2. Coupling, Screws

3. Ball valve bracket DN 10–32 (L-port)

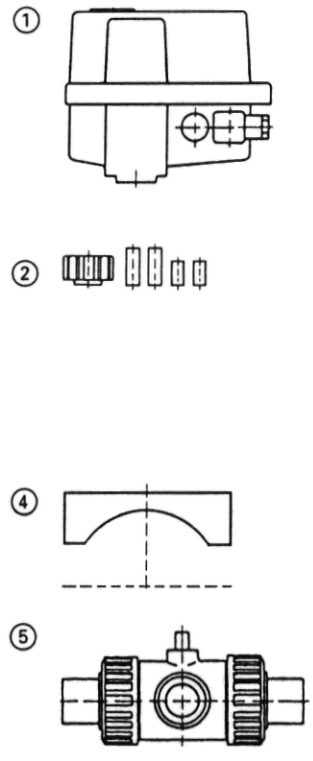
4. Ball valve bracket DN 40–50 (L-port) DN 10–50 (Multiport mixing valve)

5. 3-way ball valve Type 343

L-port DN 10–50

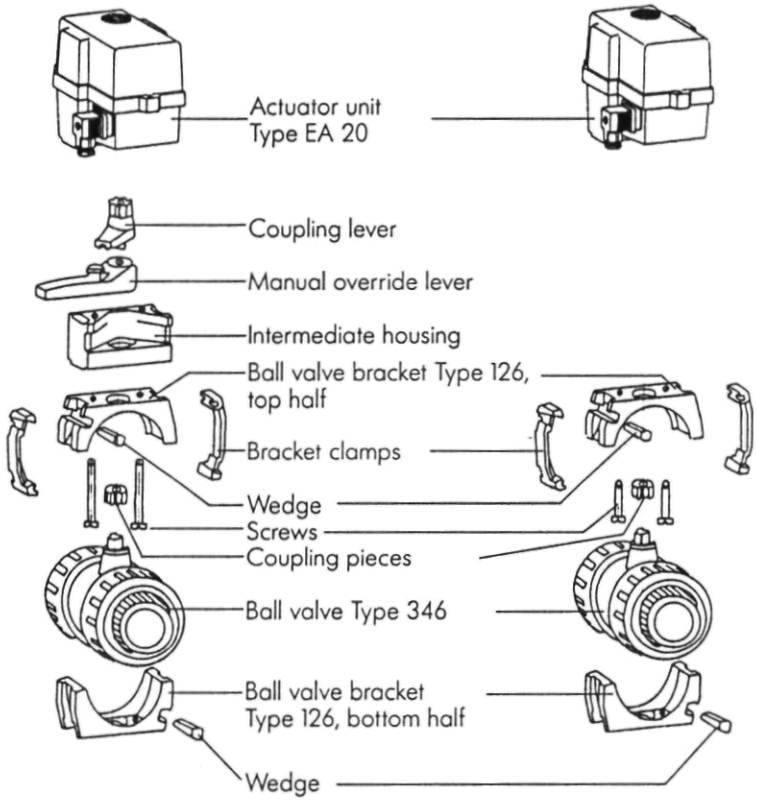


Multiport mixing valve DN 10–50



3.2 Ball valve Types 111–113

With manual override **Without manual override**



Procedure

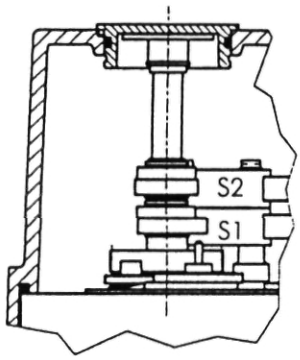
(Ball valve with manual override)

- Screw the top half of the ball valve bracket to the actuator, together with the intermediate housing, manual override lever and coupling lever
- Fit the ball valve into the bottom half of bracket
- Place the actuator with the top half of the bracket on the ball valve, install the bracket clamps and fix with wedges.

4. Installation of the actuator

Warning:
Before the actuator is connected to the mains, the following must be checked:

- is the actuator adjusted to the correct mains voltage
  (see Item 2.1)
- are the electrical connections correct
  (see Item 2.2)



Adjustments
If a complete actuated valve is being supplied by George Fischer, no further adjustments are necessary. If the customer assembles the unit or if a repair has been done, the end positions must be checked and if necessary adjusted.
Adjustments can only be done on dismounted valves.

Limit switch positions:
Switch S1 opens at «open» position
Switch S2 opens at «closed» position
(see diagram in the margin)

Procedure
Both switching cams S1 and S2 are to be adjusted so that the actuating angle is less than 90° ∢.
Drive the actuator until one limit switch, is operated. The end positions can be adjusted by moving the switching cams, as the actuator follows them.

5. Specifications

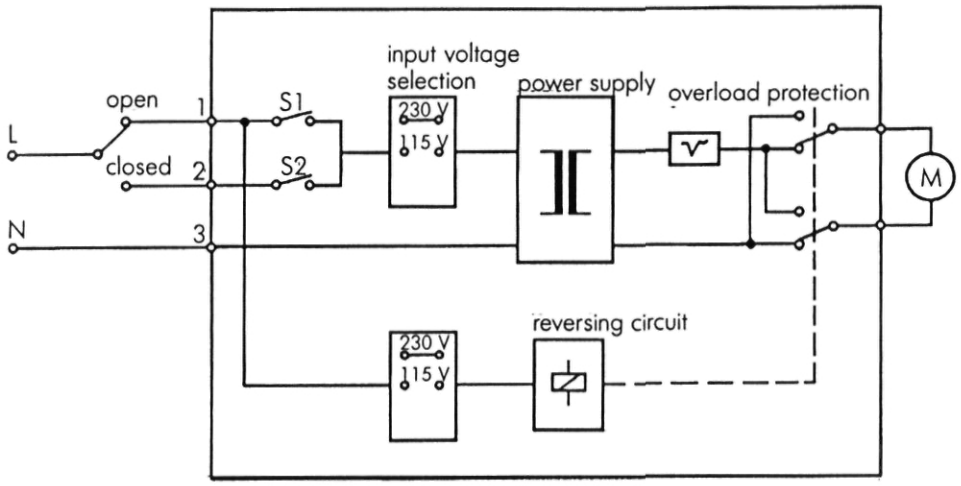
5.1 Actuator unit

Nominal voltage	115/230 V, 50–60 Hz (switchable) 24 V ⎓ / 24 V, 50–60 Hz 48 V, 50–60 Hz on request
Power consumption	12 W
Protection	IP 65 in accordance with DIN 40050
Duty cycle	100% at 25 °C / 70% at 50 °C, 20 min
Overload protection	Dependent on current and time (automatic reset) [1]
Electric connection	Cable plug 3 P+E in accordance with DIN 43650 additional cable connections PG 11
Control time	6 s / 90° ∢
Angle of operation	max. 270°, set to 90°
Continuous torque	12 Nm
Peak torque	25 Nm
Operating temperature	–10° to +50 °C [2]
Permissible humidity	0–98%, non-condensing
Body material	PP fiberglass reinforced external screws rust-proof
Position indicator	visual, integrated

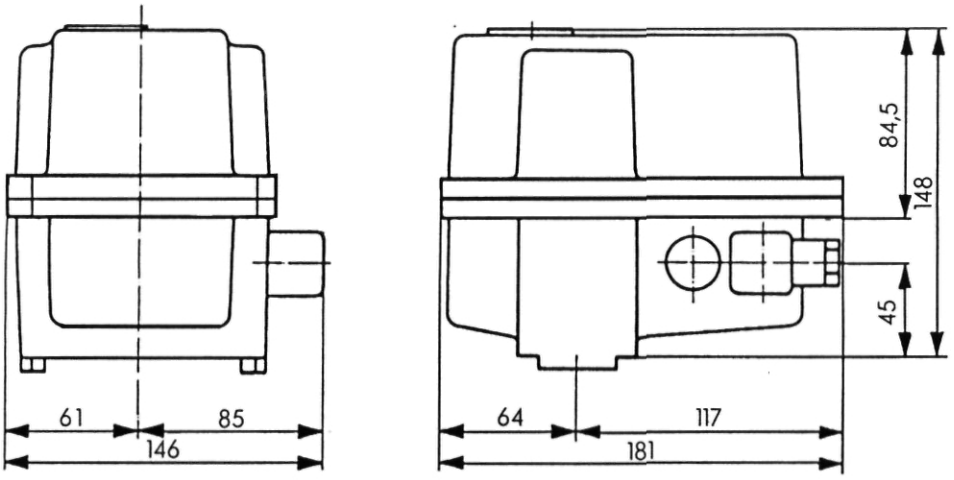
[1] The overload protection is designed to protect both motor and power supply board. If the overload protection device has triggered, it will reset automatically when the unit has cooled down sufficiently and the actuator will operate again.

[2] For temperatures below –10 °C the heating element Nr. 198 190 142/ . . 143 should be installed (see Item 6.6).

5.2 Block Diagram



5.3 Dimensions



6. Assembly and Connection of Modular Components

The electrical actuator EA 20 is equipped with fastening points which allow for additional modular components to be mounted.

The configuration of these points is described under Section 2. The electrical connection is made by means of a second cable plug or a threaded cable joint Pg 11 (depending on the number of connecting wires). The respective kits are prepared for installation, the electric cables are cut to size and packaged accordingly.

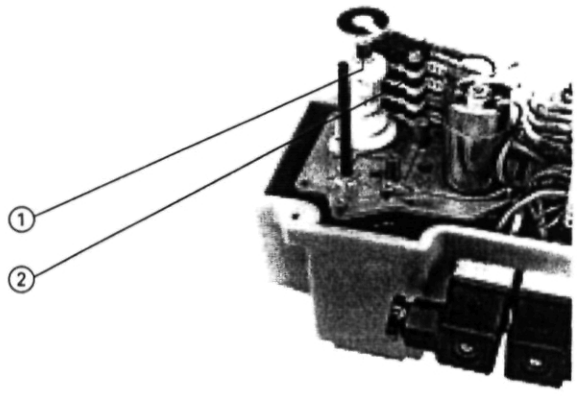
In the following sections, the corresponding assembly points and the wiring are illustrated.

6.1 Intermediate position

Description	Technical Data	Code
Set of 2 additional auxiliary switches for intermediate position	250 V ~, 10 A	199 190 141

1 Additional switching cams

2 Limit switches S3, S4



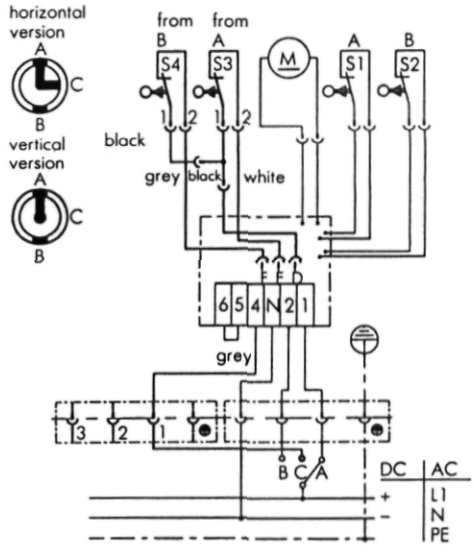
Adjust the central position

1. Adjust the «Open» A and «Open» B (fine adjustment by moving the cams with a small screw driver).
2. Move the actuator to position C (from B outgoing).
3. Move the cam S3 by rotating clockwise to the change over point.
4. Move the cam S4 by rotating anticlockwise to the change over point.
5. Connect the D/E and connections according to diagram.

Note:
Do not insert the connections D/E and F yet.

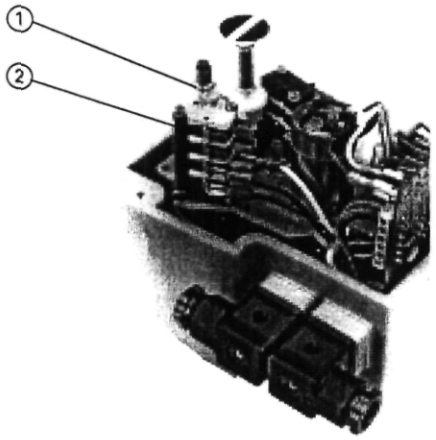
Caution:
Connections to S3 and S4 are under supply voltage.

Wiring diagram Nr. 199 190 141



6.2 Mechanical limit switches

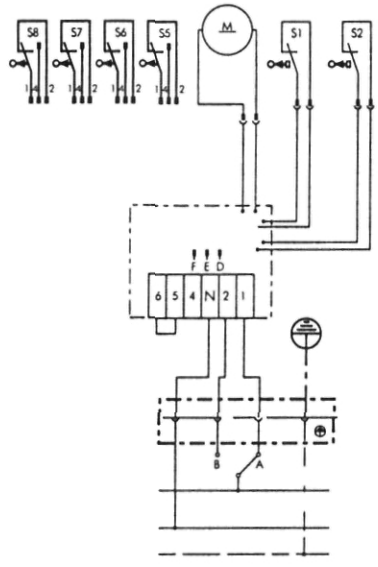
Description	Technical Data	Code
Kit with 2 additional auxiliary switches	250 V ~, 10 A	199 190 138
Kit with 4 additional auxiliary switches	250 V ~, 10 A	199 190 139
Kit with 2 additional auxiliary switches with gold contacts	4–30 V ⎓ 1–100 mA	199 190 149



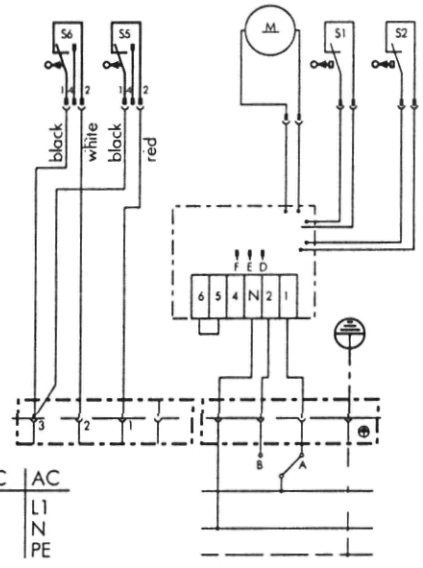
1 Additional switching cames

2 Limit switches S5, S6 or S5 to S8

Wiring diagram Nr. 199 190 139



Wiring diagram Nr. 199 190 138 /149



DC	AC
+	L1
–	N
	PE

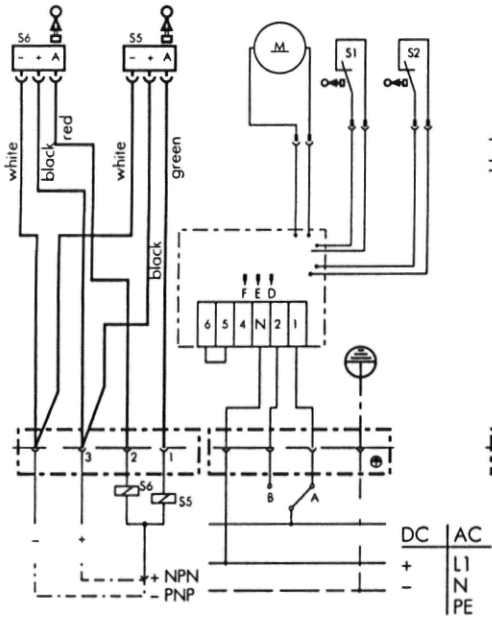
DC	AC
+	L1
–	N
	PE

6.3 Inductive limit switches

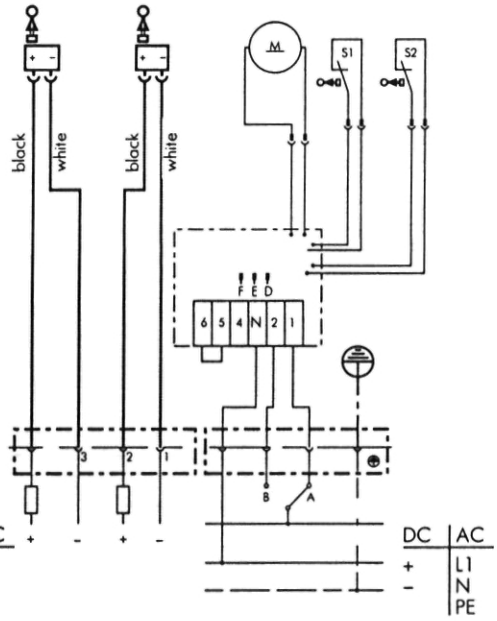
The mechanical installation of these switches is identical to those under 6.2.
An additional metal operator must be mounted so that the active surface of the inductive switch can be activated.

Description	Technical Data	Code
Kit with 2 additional auxiliary switches inductive, with LED NPN	9,6–55 V ⎓ 0,2 A	199 190 146
Kit with 2 additional auxiliary switches inductive, with LED PNP	9,6–55 V ⎓ 0,2 A	199 190 147
Kit with 2 additional auxiliary switches inductive Namur	5–24 V ⎓ 10 mA	199 190 148

Wiring Diagram
Nr. 199 190 146 NPN
Nr. 199 190 147 PNP



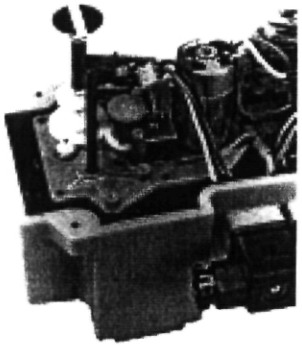
Wiring Diagram
Nr. 199 190 148



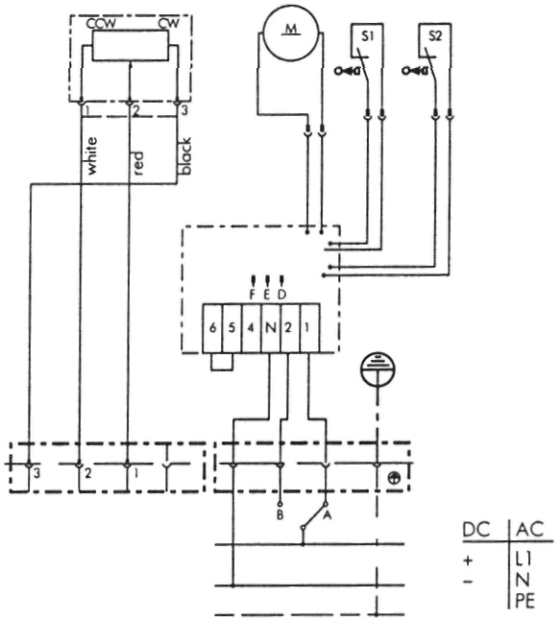
6.4 Potentiometer

The potentiometer must be mounted on **closed** valves. Before mounting, the potentiometer must be turned to the end position, so that 0–Ω is measured between the red and the white connecting wires.

Description	Technical Data	Code
Potentiometer kit	1–kΩ	199 190 140



Wiring Diagram
Nr. 199 190 140

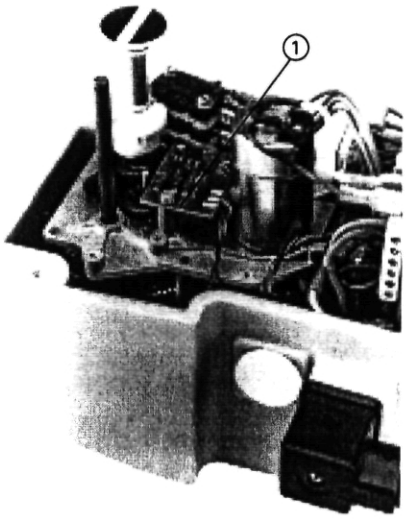


6.5 Operating time adjustment module (Vario)

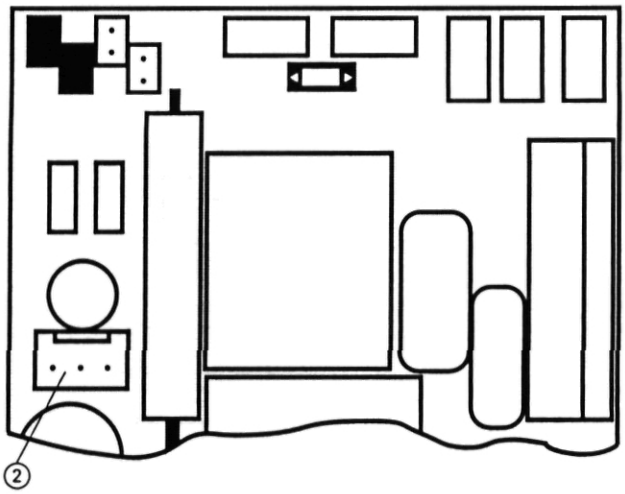
T = 10–80 seconds, Nr. 199 190 144
(The vario drives the motor stepwise.)

Description	Technical Data	Code
Operating time adjustment module	10–80 s	199 190 144

1 Potentiometer for time adjustment
↶ time is reduced
↷ time is extended

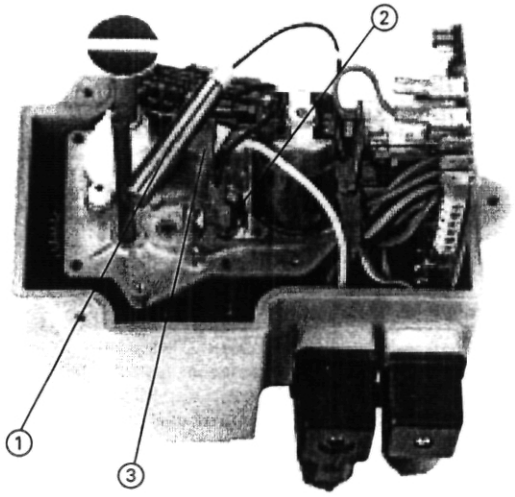


2 The operating time adjustment module is connected electrically to this plug (2) on the power supply unit.



6.6 Heating element

Description	Technical Data	Code
Heating element	100–120 V, 50–60 Hz 200–240 V, 50–60 Hz	199 190 142
Heating element	24 V ⎓ / ~	199 190 143

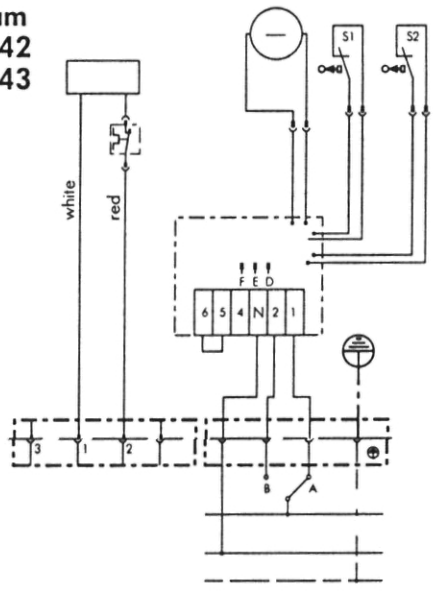


1 Heating cartridge

2 Temperature switch
Switching point on: 0 °C
Switching point off: + 5 °C

3 Mounting bracket

Wiring Diagram
Nr. 199 190 142
Nr. 199 190 143



DC	AC
+	L1
–	N
	PE

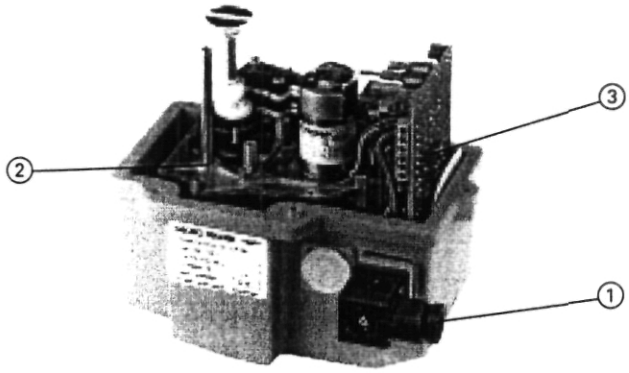
7. Troubleshooting Guide

Problem	Possible Error	Solution
Motor does not run	no mains voltage (terminal 1, 2, 3)	find customer's error
	internal wiring error	check actuator
	switching cams S1 and S2 adjusted incorrectly	see Item 4
Motor only runs in one direction	throw-over relay does not function	replace power supply board
Transformer gets very hot	wrong input voltage selected	see Item 2.1
Overload protection triggers (self resetting)	friction torque of valve too high	clean and lubricate valve
	defective motor	replace motor
	duty rating too high	increase cycle time
		apply measures to decrease ambient temperature
Valve does not close or open correctly	switching cams S1 and/ or S2 not adjusted	see Item 4

For customer service please consult the specialist at your nearest George Fischer sales office.

8. Individual Parts / Spare Parts

	Description	Code
1	Unit plug, complete	**198 000 147**
2	Gear box and motor (irrespective of voltage)	**198 800 972**
3	Power supply unit 115/230 V ~/ 50–60 Hz 24 V ⎓ / ~ 48 V ~	 **198 150 586** **198 150 587** **198 150 588**
	Electrical Actuator, complete 115/230 V ~/ 50–60 Hz 24 V ⎓ / ~ 48 V ~ / 50–60 Hz	 **198 150 431** **198 150 433** **198 150 450**
	Cover set consisting of: 1 cover — 1 clamp 1 showcase inspection glass — 1 seal 1 O-Ring — 5 PT-screws	**198 000 138**
	Sealing set consisting of: 4 screw — 1 sealing ring 5 PT screw — 4 spring washer 1 shaft seal — 1 O-Ring	**198 000 139**
	Limit switch set consisting of: 2 limit switches 4 screws 4 washers	**198 000 140**
	Position indicator	**198 800 899**



d mm	**DN** mm	**Zoll**	Intermediate element with manual override	Intermediate element without manual override	Ball valve bracket Type 126
16	10	3/8	**198 000 100**	**198 000 110**	**161 126 005**
20	15	1/2	**198 000 100**	**198 000 110**	**161 126 005**
25	20	3/4	**198 000 101**	**198 000 111**	**161 126 007**
32	25	1	**198 000 102**	**198 000 112**	**161 126 008**
40	32	1 1/2	**198 000 103**	**198 000 113**	**161 126 009**
50	40	1 3/4	**198 000 104**	**198 000 114**	**161 126 010**
63	50	2	**198 000 105**	**198 000 115**	**161 126 011**

Series 1000

by Data Industrial

Owner's Manual

Data Industrial

7/93

PN# 72077

Table of Contents

Data Industrial Corporation
11 Industrial Drive
Mattapoisett, Ma. 02739
508-758-6390
FAX: 508-758-4057

Introduction

Model 1000

The Model 1000 is a microprocessor-based liquid flow monitor designed to provide accurate reading of flow rate and total accumulated volume. It calculates and displays flow rate based on the input frequency from any Data Industrial non-magnetic flow sensor and the inside diameter of the pipe being monitored. The inside pipe diameter is entered by membrane switches on the front panel. The Model 1000 provides flow rate in gallon per minute and total flow in gallons. The Model 1000C provides units of cubic feet per minute and total cubic feet. Both the Model 1000 and 1000C use pipe diameters in inches. The Model 1000L provides units of liters per minute and total liters. The Model 1000M provides units of cubic meters per minute and total cubic meters. The Models 1000L and 1000M use pipe diameters in millimeters. It is possible to convert one model to another using available conversion kits.

Data Industrial sensors provide an input frequency which is proportional to flow rate. A preamplifier is contained in each sensor, allowing the pulse signal to travel up to 2000 feet without additional amplification. Power to operate the sensor is provided by the Model 1000. The impeller, shaft and O-rings are replaceable in the field.

The Model 1000 provides a pulse output, programmable from the face keypad, to drive an optional mechanical totalizer, relay, or to interface with other data collection equipment that can accept a pulse or dry contact closure signal.

The resettable electronic totalizer eliminates the need for an electro-mechanical counter in most applications. It retains its memory of total flow for 10 years even when power is lost.

The Model 1000 may be "locked" to prevent unauthorized access or inadvertent resetting of total flow or changes to calibration of diameter and pulse output. The unit can be unlocked from the keyboard by an authorized user.

Model 1200

The Model 1200 Calibrator is a microprocessor-based unit designed to aid in the calibration of Data Industrial analog output devices. It calculates and displays the flow in units of gallons per minute based on the input frequency from any Data Industrial analog output device (or flow sensor) and the inside diameter of the pipe being monitored. The inside pipe diameter, measured in inches, is entered on the front panel keys. Other units of measure for diameter, flow rate and total flow are available.

All Data Industrial analog transmitters may be adjusted in the field for full scale flow range. When connected to the sensor terminals of the transmitter, the Model 1200 will display the full scale in GPM when the appropriate pipe I.D. is entered, providing a visual indicator when adjusting the analog transmitter. It is powered with two 9 V alkaline batteries.

Model 1000 Installation

Location

In any mounting arrangement, the primary concern is easy viewing and convenient operation of the keyboard.

The unit generates very little heat, so no consideration need be given to cooling or ventilation.

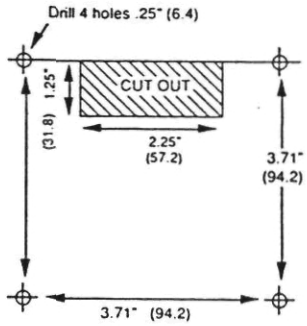
Mechanical Installation

Surface Mounting

The Model 1000 can be mounted on any flat panel, requiring only a small opening in the panel to clear the electrical connector and 4 screw holes for mounting. It projects only 1 1/2" from the panel.

1) Remove dress plugs from the front of the unit.
2) Drill holes in panel for screws and cut out for electrical connector as shown in Figure 1.
3) Screw unit down with user-provided screws for the .25" holes.
4) Replace dress plugs on front of the unit.

Figure 1
Surface Mounting



(Dimensions in parentheses = mm)

Flush Mounting

1) Remove dress plugs from the front of the unit.

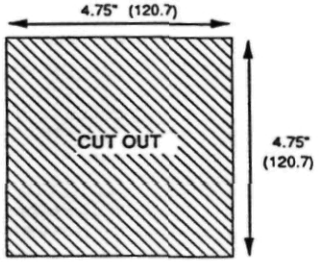
2) Take 8-32 screws provided and place through front of the unit. Tighten the screws to the rear cover so that they act as projecting studs.

3) Place the flush mount plate over the dress plug holes in the front of the unit and screw in the 4 adapters provided.

4) Cut out 4.75" x 4.75" hole as shown in Figure 2.

5) Take the 2 U-brackets provided and fit them over the 8-32 screws. Using nuts provided, clamp the unit to panel with the U-brackets.

Figure 2
Flush Mounting



(Dimensions in parentheses = mm)

Conduit Box Mounting

1) Remove dress plugs from the front of the Model 1000.

2) Put lock-washers onto conduit box spacers and screw into back of Model 1000.

3) Attach a waterproof conduit fitting with grounding lug in bottom of conduit box.

4) Align box to spacers so that hole for wiring will be facing down when unit is finally mounted, as shown in Figure 3A.

5) Use 4 seal screws to attach box to Model 1000. Make sure that the box edge firmly and evenly seats against the gasket in the rear panel.

6) Replace dress plugs on the front of the unit. Make sure O-ring seals are intact.

7) Mount the unit using the welded brackets provided on the conduit box. Refer to Figure 3B for the welded bracket dimensions.

Figure 3A
Conduit Box Attachment

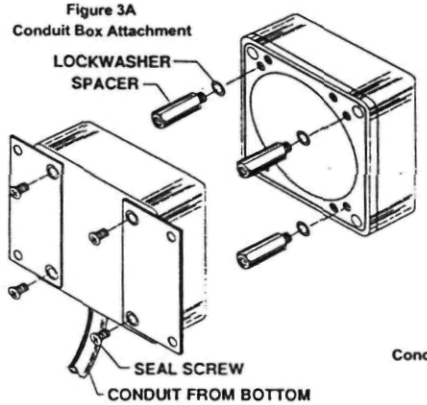
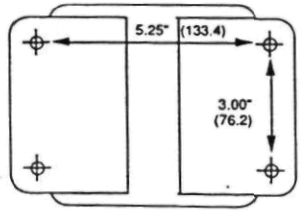


Figure 3B
Conduit Box Mounting



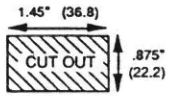
(Dimensions in parentheses = mm)

Electromechanical Totalizer

1) Cut an opening .875" x 1.45" in panel as shown in Figure 4.

2) Lift wire clip up, insert through opening, and bring clip down to engage it. The clip has two possible positions on the totalizer in order to handle a wide range of panel thicknesses.

Figure 4
Electromechanical Totalizer



(Dimensions in parentheses = mm)

Relay Output

This is already mounted and wired except for your contact closure connections. See the electrical installation section of this manual.

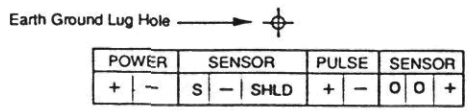
Electrical Installation

Make sure all other flow sensor and pulse connections are wired before applying power to the unit. **Warning**: This meter operates only on DC power. Voltages between 10 VDC and 30 VDC are allowed. To power from an AC power source, order the AC adapter as described in the "Options" section of *Specifications*.

Power Cable

Connect black with white stripe wire to power positive (+), black wire to power negative (-). Refer to Figure 5 for diagram of the terminal strip for this part of the installation.

Figure 5
Terminal Strip



Pulse Output

If an external totalizer or other device is being used, connect positive lead to pulse positive (+) and negative lead to pulse negative (-).

Flow Sensor

1) **Series 200:** Connect red wire to sensor signal (s), third terminal from the left, and the black wire to sensor negative (-), and bare wire to sensor SHLD.

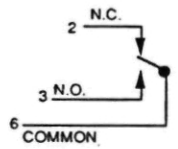
2) **Series 4000:** Connect red wire to sensor positive(+) end terminal on the right, black wire to sensor negative (-), white wire to sensor signal (s), bare wire to sensor shield (SHLD).

3) The Model 1000 supplies 10-12VDC to the sensor terminals through a 1K ohm source impedence, which is regulated to 8VDC at .5 ma current by the sensor. For safety, this low voltage is electronically isolated from the DC line. If the sensor is to be located in a hazardous area, we recommend that the sensor leads be interrupted by an intrinsically safe barrier.

Relay Output

The relay coil wires have already been connected to the terminal strip at the factory. For contact connections, simply crimp the lugs provided to your wires and connect to the relay contacts, as shown in Figure 6.

Figure 6
Relay Output



Earth Ground

For surface or flush mount
Attach green wire with terminal lug to tapped hole above terminal strip with screw and lock washer. Attach other end to Earth Ground.

For conduit box mounting
Ensure that the green wire is also attached to the conduit fitting to ensure that the conduit box is grounded.

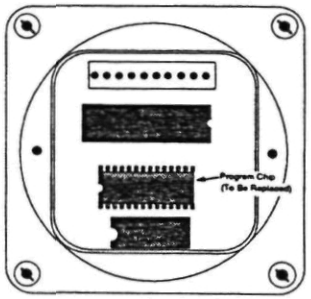
Units Conversion Kits

1) Turn off power to the unit and disconnect all wires.

2) Remove the round rear panel access cover with a Phillips screwdriver.

3) Locate the program chip on the circuit board (refer to Figure 7). This is the chip with a label on it which is inserted in a socket.

Figure 7
Locating and Removing Program Chip



4) Using a wide blade screwdriver, and working first from one side and then the other, gently pry up the chip to remove it from the socket. Be sure to insert the blade *between* the socket and the chip, rather than underneath the socket, as you could damage the socket leg. Take care to avoid contact with the circuit board as circuit traces can easily be damaged.

5) Handle the replacement program chip with care. It is sensitive to small electrical discharges such as static electricity. Before handling, touch a grounded metal surface with your hands. If the pins of the chip are splayed and do not match the socket row spacing, lay the chip on a flat, clean surfact and bend them slightly (refer to Figures 8 and 9).

Figure 8
Correct Pin Angle

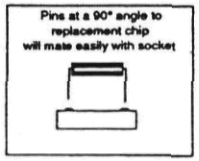
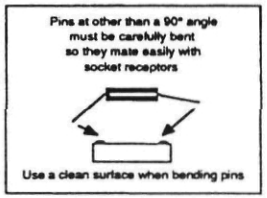


Figure 9
Correcting Splayed Pins



6) Orient the chip so that the notched end of the chip matches the notch in the socket body (notch to the left with the unit upright). Refer to Figures 10 and 11. Gently and firmly press the chip into the socket until it bottoms out, ensuring that all pins mate properly.

Figure 10

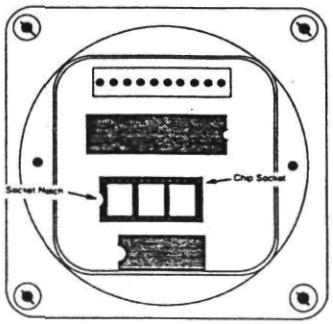
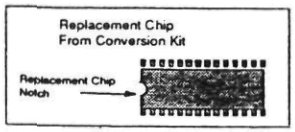


Figure 11



7) Replace the access cover and reconnect the wires to the unit.

NOTE: After making the conversion, some difficulty may be encountered in operating the Model 1000 when it is first turned on. This is because previously legal values of pipe diameter still stored in the memory are often illegal using the new programmed units of measure. Your display may show "CAL" or "18.8.8". Turn the power to the unit OFF for a few seconds and back ON. Check and reset if necessary all values of diameter, total flow, units/pulse, and security code before using the converted Model 1000.

8) Apply the new units of measure label to the front panel of the Model 1000. If the old units were CFM, LPM, or CUBIC METERS, remove the old label. Clean the base label above the display using alcohol and a lint-free cloth or paper-wipe. Peel off the backing on the new label and apply it above the display. Once positioned, press the entire label surface to set the pressure-sensitive adhesive.

9) Using a permanent marking pen, add the letter "C" (CFM), "I" (IMP GAL), "L" (LPM), or "M" (CUBIC METERS) at the end of the model number on your serial number label(s); or change the model no. to a #1019 if you've opted for the Auto Restart option.

Operation

Model 1000

The front access keyboard provides membrane switches that enter the pipe size, select flow rate or total flow for display, reset the total flow to zero, set the desired pulse output in gallons-per-pulse, and to enter and change the security code. **Note**: If you find that you can display settings but cannot reset them, read the section entitled "Unlocking/Using the Security Code."

The following instructions assume your monitor is a Model 1000 with units of GPM, GALLONS, and inches of pipe diameter. If your monitor is a Model 1000C, 1000L, or 1000M, the operation is the same but the units are as marked on the front panel.

Model 1200

The Model 1200 is powered by two (2) standard 9V transistor batteries (customer supplied) located under the rear cover, with an ON/OFF switch located on the rear of the conduit box cover. A 6-foot cable with alligator clips is provided for signal input connections. Connect as follows:

Model 1200	220 Series Flow Sensor	4000 Series Flow Sensor	Display or Analog Transmitter
Red	N/C	Red	N/C
Black	Black	Black	- Sensor Input
White	Red	White	+ Sensor Input
Yellow	Shield	Shield	Shield

Flow sensors connect as shown in the table above. Note that the wires are not necessarily paired color for color, and all connections not always required, depending on the type of sensor being used.

When connecting to an analog transmitter such as the Model 750M or a Model 500, the WHITE wire of the Model 1200 should be connected to the (+) SENSOR INPUT, while the BLACK wire is connected to the (-) SENSOR INPUT wire. No other connections are required; however, these connections can be shared with a flow sensor if desired. This is especially useful in final system check-out.

Initial Settings

PIPE DIAM

1) Measure the pipe diameter as accurately as possible. The proper pipe diameter has a large effect on the flow rate accuracy. A table of common pipe sizes with schedules and their inside diameters are provided in the *Specifications* Section.

2) Pipe diameter resolution is from 0.00 to 19.99 in hundreds of an inch and from 20.0 to 40.0 in tenths of an inch (0.0 to 199.9 in tenths of a mm and 200 to 1016 in whole mm).

3) For pipe sizes that are from 3" up to 40.0" (76.2 to 1016 mm), any pipe diameter may be entered. For pipe sizes that are below 3" (76.2 mm), only the diameter for the Data Industrial tee and sensor series can be entered, as shown in the tables in the *Specifications* Section.

4) To calibrate the display, press **RESET** and then **PIPE DIAM**. The LCD will display a pipe diameter. Increase or decrease the number by pushing the up and down arrow keys on the front panel to correspond to the inside diameter of the pipe being monitored.

5) When increasing or decreasing the pipe diameter in the LCD, note that the longer the arrow key is depressed, the faster the numbers will count.

6) After entering the correct diameter, press **RESET** again.

7) The Series 1000 will begin to monitor liquid flow and totalization is returned to zero gallons.

Note: If during calibration no key is pressed for 4 seconds, the display will automatically revert to flow rate without changing the pipe diameter calibration.

UNITS PULSE **(Not available with Model 1200 unit)**

1) If a pulse output is required, it is user-calibrated by entering the number of gallons per pulse desired. Press **RESET** and **UNITS/PULSE**.

2) The setting can be made from 0.01 to 1,999,000,000 gallons per pulse in the same resolution increments used for total flow. The increment listings are provided in the *Specifications* section.

3) The maximum limit of 100 pulses per second (100 Hz) output controls how low the minimum allowed gallons/pulse may be set. The Model 1000 will not allow a setting below this low limit.

4) Setting the **UNITS/PULSE** is much like setting a digital watch. The display will show the present value with the UNITS DIGIT flashing. (Since decimals and multipliers may be used, UNITS DIGIT refers to the rightmost digit even though it may represent tens, hundreds, etc.)

5) Press the up or down keys to set the UNITS DIGIT. Press **RESET** to enter the UNITS DIGIT. The display will freeze the UNITS DIGIT and flash the TENS DIGIT.

6) Repeat this setting and entering procedure for the TENS and HUNDREDS DIGITS.

7) Next, the leftmost decimal point will begin to flash. Press the up key to move the

decimal to the right. Additional presses of the up key will cause the display of no decimal and then the multiplier setting.

8) Once the decimal or multiplier is set, press **RESET** one more time to enter this value.

9) Press **RESET** a final time to enter the **UNITS/PULSE** value.

Note: Entering a new pipe diameter will automatically reset the **UNITS/PULSE** output to 00.00.

Display Operation

FLOW RATE

- Pressing the **FLOW RATE** membrane switch displays the current flow rate with the word "FLOW". Display resolution is described in the *Specifications* section.
- Update rate is 1 second. The display will continue to show flow rate until some other key is pressed.

FLOW TOTAL

- Pressing the **FLOW TOTAL** membrane switch displays the flow (in gallons) accumulated since the last manual reset with the words "TOTAL" and "FLOW". Display resolution is the same as for flow rate.
- The electronic totalizer retains its memory of total flow even when power is lost, and will begin where it left off when power resumes.
- Update rate is 1 second. The display will continue to show total flow until some other key is pressed.
- Pressing **RESET** then the **FLOW TOTAL** membrane switches resets the unit.

RESET then FLOW TOTAL

- The display will show "00.00" and will then resume accumulating total flow.
- **Note:** Entering new pipe diameter will automatically reset total flow to 00.00.

PIPE DIAM

- Pressing the **PIPE DIAM** membrane switch will show the stored value of pipe diameter for four (4) seconds, then default to flow rate.

UNITS PULSE **(Not available with Model 1200 unit)**

- The display will show the stored units/pulse value for four (4) seconds, then default to flow rate.

Fault Displays

Power interruptions, lightning strikes, or other electrical problems can cause faults to occur in the Series 1000.

Power Interruptions

- Should power be interrupted for more than a few seconds, when power is restored the Series 1000 will resume operation, but "—" will be shown in the display.
- Pressing any key will resume normal display, but total flow should be questioned since some flow volume may be unaccounted for during the power interruption.
- A-1019 Software Option will start up on Flow Rate. When toggled to Total, the legend "Total Flow" will flash at 1 second intervals. Pressing "Total" once will cause the flashing legend to stop.

Electrical Problems

- The Series 1000 continuously checks for valid settings. If problems exist due to an electrical fault, the display will show "CAL". In this case, it will be necessary to reset the initial settings as described earlier.

Battery Replacement (Model 1200 only)

The Model 1200 will operate for approximately 6 hours of continuous operation.
To replace batteries:

1) Always slide the battery switch on the back cover to "OFF".

2) Unscrew the 4 screws on back cover. Remove cover, being careful not to strain the internal wiring.

3) Loosen the 2 screws which clamp down the battery bracket.

4) Unsnap the battery connectors, slide out the 2 batteries, and replace.

Unlocking Using the Security Code (Model 1000 only)

You can choose to "lock" your Model 1000 by using the security code feature. Once the Model 1000 is locked, the total accumulated flow volume may not be reset and the pipe diameter and units/pulse calibration settings may not be changed without first entering the proper code. As shipped from the factory, the Model 1000 is unlocked and will remain so unless you change the code setting. See the instructions for changing the security code on the last page of this manual.

Located above the "PIPE DIAM" key is a hidden key.
To unlock the Model 1000:

1) Press the hidden key. The display will show "000" with the units (rightmost) digit flashing.

2) Press the up or down keys to set the units digit, then press RESET to enter it. The display will freeze the units digit and flash the tens digit.

3) Repeat this setting and entering procedure for the tens and hundreds digits.

4) After you enter the hundreds digit, the Model 1000 accepts the code you have entered and compares it to the security code in memory. If you have entered the correct code, the display will show "SET." If not, it will default to display of flow rate without unlocking.

5) Once unlocked, you can reset the total and change the calibration settings. If a period of 10 seconds elapses with no key presses, the Model 1000 will automatically return to the locked state.

Specifications

1000 Series

Liquid Measurement Units
- Gallons per minute and total gallons (Model 1000)
- Liters per minute and total liters (Model 1000L)
- Cubic feet per minute and total cubic feet (Model 1000C)
- Cubic meters per minute and total cubic meters (Model 1000M)

Flow Calibration Range
- 0.50" to 40.00" pipe sizes (12.7 to 1,016 mm)

Display Resolution for the *FLOW RATE* and *TOTAL FLOW* indicators
0.0 to 199.9 in tenths
200 to 1,999 in whole numbers
2,000 to 19,990 in increments of 10
20,000 to 199,900 in increments of 100
200,000 to 1,999,000 in increments of 1,000
2,000,000 to 19,990,000 in increments of 10,000
20,000,000 to 199,900,000 in increments of 100,000
200,000,000 to 1,999,000,000 in increments of 1,000,000

Display Update Rate
- One (1) second

Temperature Ranges
- Operating Temperature: 32° to 158°F (0° to 70°C)
- Storage Temperature: -40° to 194°F (-40° to 90°C)

Dimensions
- Model 1000: 4.63" x 4.63" x 2.25"
- Model 1000 Surface Mounted: 4.63" x 4.63" x 1.50"
- Model 1000 Flush Mounted: 5.665" x 5.665" x .125"
- Model 1000 Conduit Box Mounted: 4.63" x 4.63" x 3.75"

Weight
- 2.8 pounds

Case
- Cast Aluminum
- Front panel meets NEMA 4x rating

Power for Model 1000
- 9-34VDC
- Reverse and overvoltage protected to 34 VDC
- Power off continuous memory of total accumulated flow, pipe diameter and units/pulse calibration
- 60 milliamp power consumption, including sensor

Power for Model 1200
- Two 9 V alkaline batteries
- Power off continuous memory of total accumulated flow and pipe diameter
- 60 milliamp power consumption

Model 1000 only

Pulse Output
- 0 to 100 Hz. 100 millisecond pulse width at supply voltage to 5 Hz
- Pulse width narrows to 50% duty cycle above 5 Hz
- Maximum current allowed is 1 amp
- User-settable resolution from .1 to 2 billion flow units per pulse, limited by input frequency of sensor (consult the factory).

Optional Relay
- SPDT contact ratings: 10 amps @ 240 VAC; 15 amps @ 30 VDC or 150 VAC
- Coil voltage ratings: 12 VDC relay = 10-14 VDC; 24 VDC relay = 20-28 VDC
- User settable to pulse output rate
- 20 closures per second maximum
- Closure rate and duration controlled by pulse output setting
- Operating temperature: 32°-130°F (0-55°C)

Optional Totalizer
- Totalizer voltage ratings: 12 VDC = 10-14 VDC; 24 VDC = 20-28VDC
- 7-digit nonresettable electro-mechanical totalizer
- Resolution same as for pulse output
- User settable to pulse output rate
- Operating temperature: 32°-122°F(0-50°C)

Options for Model 1000

Flush Mounting Kit
- Part No. A1003 allows recessed mounting in panel. Hardware adapts to 144 mm square DIN specification 43700. Cutout may be as small as 4.75" x 4.75".

Conduit Box Kit
- Part No. A1001 covers the rear panel with a weatherproof enclosure for stand-alone mounting in an outdoor or unprotected location. Meets NEMA 4x. Opening provides for standard 1/2" conduit fitting. Mounting brackets are welded to aluminum enclosure, allowing surface mounting to any flat surface. Total assembled dimensions are 4.63" x 4.63" x 3.75".

Factory Installed Relay Output Kit

Closure rate and duration for both are controlled by the Model 1000 pulse output setting.
- Part No. A1004: Unit provided with an SPDT relay. Nominal 12 VDC coil voltage.
- Part No. A1010: Unit provided with an SPDT relay. Nominal 24 VDC coil voltage.

Electromechanical Totalizer Kit

Resolution for both is user-settable; uses the gallons per pulse feature of the Model 1000.
- Part No. A1008: 12 VDC 7-digit non-resettable totalizer for panel mounting.
- Part No. A1009: 24 VDC 7-digit non-resettable totalizer for panel mounting.

AC Power Adapter
- Part No. A1006: U.L. approved 120 VAC outlet plug-in power supply to provide 12 VDC to the Model 1000.
- Part No. A1015: 220-250 VAC 50/60 Hz AC power adapter.
- Part No. A1016: 120 VAC barrier strip power supply to provide 12 VDC

Units Conversion Kit
- Part No. *A1011:* Program chip and units label for conversion to GPM/GALLONS.
- Part No. *A1012:* Program chip and units label for conversion to CFM/CUBIC FEET.
- Part No. *A1013:* Program chip and units label for conversion to LPM/LITERS.
- Part No. *A1014:* Program chip and units label for conversion to CUBIC METERS/MIN, CUBIC METERS.
- Part No. *A1019:* Program chip for automatic restart of unit after power loss. Auto Start displays Rate, Total legend flashes until acknowledged.

TABLE FOR ENTERING

DATA INDUSTRIAL TEE AND SENSOR INFORMATION

Data Industrial Sensor Type	1000, 1000C I.D. to be entered into Digital Display (inches)	1000L, 1000M I.D. to be entered into Digitial Display (mm)
220P-1, 228 PD-1	.96	24.4
250B-1	1.05	26.7
250B-1.25	1.38	35.1
220P-1.5, 228PD-1.5	1.50	38.1
228C C.I. Tee with 1.5" Inlet Pipe	1.61	40.9
228SS C.I. Tee with 1.5" Inlet Pipe	1.61	40.9
250B-1.5	1.62	41.1
228PF-1.5	1.71	43.4
228PF-2	2.21	56.1
220P-2, 228PD-2	1.94	49.3
228B-2	1.99	50.5
228C-2 (150 PSI Tee)	2.07	52.6
228SS-2	2.07	52.6
228C-2 (400 PSI Tee)	2.10	53.3
228C-2.5	2.51	63.8
228B-2.5	2.52	64.0
220B, 225B, 226B, in 2 1/2" pipe, no tee	2.47	62.7
220SS, 226SS in 2 1/2" pipe, no tee	2.47	62.7
220P-3, 228PD-3	4.02	102.1
220P-4, 228PD-4	5.15	130.8

Typical Pipe Sizes: Inside Diameter (inches)

Pipe Size	Steel Pipe Sched 40	Steel Pipe Sched 80	PVC Pipe Class 100	PVC Pipe Class 125	PVC Pipe Class 160
3"	3.07			3.28	3.23
4"	4.03	3.83	4.28	4.22	4.15
5"	5.05	4.81	5.29	5.22	5.13
6"	6.06	5.76	6.30	6.22	6.12
8"	7.98	7.62	8.21	8.10	7.96
10"	10.02	9.56	10.27	10.09	9.92
12"	11.94	11.38	12.13	11.97	11.77
14"	13.12	12.50			
16"	15.00	14.31			
18"	16.88	16.13			
20"	18.81	17.94			
24"	22.63	21.56			

CAUTION: The above listed Inside Diameters refer to clean, new pipe. Adjustments should be made when scaling or buildup of deposits are present.

Warranty

Data Industrial Corporation ("Seller") of 11 Industrial Drive, Mattapoisett, Massachusetts 02739, U.S.A., warrants to the original purchaser of its product that such product manufactured by Data Industrial Corporation shall be free from defects in materials or workmanship when installed, serviced and operated according to Data Industrial corporation instructions or in other such normal use. This warranty is effective for a period of 12 months from the date of installation by the Purchaser or 18 months from the date of shipment by the "Seller" whichever occurs or terminates first. This limited warranty does not cover damage or loss resulting from corrosion or erosion cased by acids or other chemicals or negligent installation improper operation, misuse, accident, unauthorized repair or substitution of components other than those provided by the "Seller", and does not cover limited life components such as bearings, shafts, impellers where wear rate is a function of application. Any component not manufactured by the "Seller" but included in its products shall not be covered by this warranty and is sold only sunder such warranty as the manufacturer may provide.

If Buyer or Purchaser wishes to make a claim hereunder, he shall send written notice of any defect within the warranty period, to "Seller" at the above address. "Seller" may at its sole option instruct Buyer to ship subject part, postage prepaid, to the "Seller" at above address or authorize a representative to inspect the part on site. "Seller" will at its sole option repair or replace any effective product covered by this warranty. If Buyer makes repairs or alterations to any product or part covered by this warranty without "Sellers" prior written approval, this warranty shall be null and void.

The foregoing shall constitute Buyers or Purchasers sole and exclusive remedy against "Seller", and no other remedy, including but not limited to, incidental or consequential damages for personal injury, loss of fluids, gases or other substances or for loss of profits or injury to property or person shall be available to the Buyer or Purchaser. The warranty extended herein shall be in lieu of any other implied warranty of merchantability or fitness for a particular purpose, and seller shall bear no liability for representatives or retail sellers. In no event shall Data Industrial Corporation be liable for any contingent, incidental, or consequential damage or expenses due to partial or complete inoperability of its product.

Changing the Security Code

Model 1000 only

Note: This page has been kept separate and may be removed for security reasons.

As shipped from the factory, the security code is "000." This value leaves the Model 1000 continuously unlocked for ease of use. If you choose to change the code to some other value, you must enter the proper code to do anything other than display the readings of the Model 1000.

To change the security code:

1) Press and release the hidden membrane switch, located above the PIPE DIAM key, three times in succession. Press the RESET key. The display will show the present value of the security code with the units digit flashing.

2) Press the up or down keys to change the units digit, then press RESET to enter it. The display will freeze the units digit and flash the tens digit.

3) Repeat this setting and entering procedure for the tens and hundreds digits. The security code may be set for any number from 000 to 255 inclusive. Upon entering the hundreds digit, the Model 1000 stores the new security code.

4) The Model 1000 remains temporarily unlocked after changing the security code so that you can reset the total flow or recalibrate now. After 10 seconds elapse with no key presses, the Model 1000 automatically locks.

5) Test to ensure that the unit is locked by trying to reset the pipe diameter. If you press RESET then PIPE DIAM and the displayed diameter does not flash, the unit *is locked.*

6) Now test to ensure that the new security code is correct by unlocking the unit as described earlier under "Unlocking Using the Security Code."

Note: If the Model 1000 encounters electrical problems as described under "Fault Displays," the security code may default to a setting of "001." This will ensure that it remains locked even though memory may be lost. Always check the code value after a display of "CAL" due to a fault condition.

MODEL 107 AND 107B TEMPERATURE PROBES
INSTRUCTION MANUAL

REVISION: 12/92

WARRANTY AND ASSISTANCE

The **Model 107 and 107B Temperature Probes** are warranted by CSI to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise. Batteries have no warranty. CSI's obligation under this warranty is limited to repairing or replacing (at CSI's option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CSI. CSI will return such products by surface carrier prepaid. This warranty shall not apply to any CSI products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CSI is not liable for special, indirect, incidental, or consequential damages.

Products may not be returned without prior authorization. To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC, INC., phone (801) 753-2342. After an application engineer determines the nature of the problem, an RMA number will be issued. Please write this number clearly on the outside of the shipping container. Campbell Scientific's shipping address is:

Campbell Scientific, Inc.
RMA#_____
815 West 1800 North
Logan UT 84321-1784

CAMPBELL SCIENTIFIC, INC. does not accept collect calls.

Non-warranty products returned for repair should be accompanied by a purchase order to cover the repair.

CAMPBELL SCIENTIFIC, INC.

815 W. 1800 N.
Logan, UT 84321-1784
USA
Phone (801) 753-2342
TLX 453058
FAX (801) 752-3268

Campbell Scientific Canada Corp.
9525 41st Avenue
Edmonton, Alberta T6E 5X7
CANADA
Phone (403) 461-5158
TLX 037-2966 (EDM)
FAX (403) 450-2531

Campbell Scientific Ltd.
14-20 Field Street
Shepshed, Leics. LE12 9AL
ENGLAND
Phone (44) 509 601141
FAX (44) 509 601091

MODEL 107 AND 107B TEMPERATURE PROBES

1. GENERAL

The 107 Air and 107B Soil/Water Temperature Probes incorporate the Fenwal Electronics UUT51J1 Thermistor probe. Custom lead lengths are available. Do not extend lead lengths by adding wire to the pigtail (connection) end because measurement errors will result.

The 107 Temperature Probe is designed for measuring air temperature. The 107B Temperature Probe is electrically identical, but is designed to be buried or submerged up to 200 feet in water.

2. ACCURACY

The overall probe accuracy is a combination of Fenwal's interchangeability specification, the precision of the bridge resistors and the polynomial error. In a "worst case" example all of the errors add in one direction to yield accuracy of ±0.4°C over the range of -33°C to +48°C. The error is typically less than the specification. The major error component is the ±0.2°C (±0.5°C at -40°C) interchangeability specification of the thermistor from 0 to 60°C. The interchangeability error is predominantly offset and can be determined with a single point calibration. The error can then be compensated for with the offset entered in the measurement instruction.

The bridge resistors are 0.1% tolerance with a 10ppm temperature coefficient.

Polynomial errors are tabulated in Table 1 and also plotted in Figure 1.

Table 1. Polynomial Error

RANGE °C	ERROR
-40 to +56	<1.0°C
-36 to +53	<0.5°C
-33 to +48	<0.1°C

3. WIRING

The 107 schematic is shown in Figure 2. The 107 uses a single ended analog channel, the red lead "HI" can be inserted into either a HI or LO input.

The black lead connects to any excitation channel. One excitation channel will drive several hundred 107 probes. Thus, the number of 107 probes per excitation channel is physically limited by the number of lead wires that can be inserted into a single excitation terminal (approximately 10).

The purple lead connects to Analog Ground. Analog Ground, labeled "AG" on the CR10, is the same as Ground for the 21X and CR7.

The clear lead is the shield which connects to Ground (G) on the datalogger.

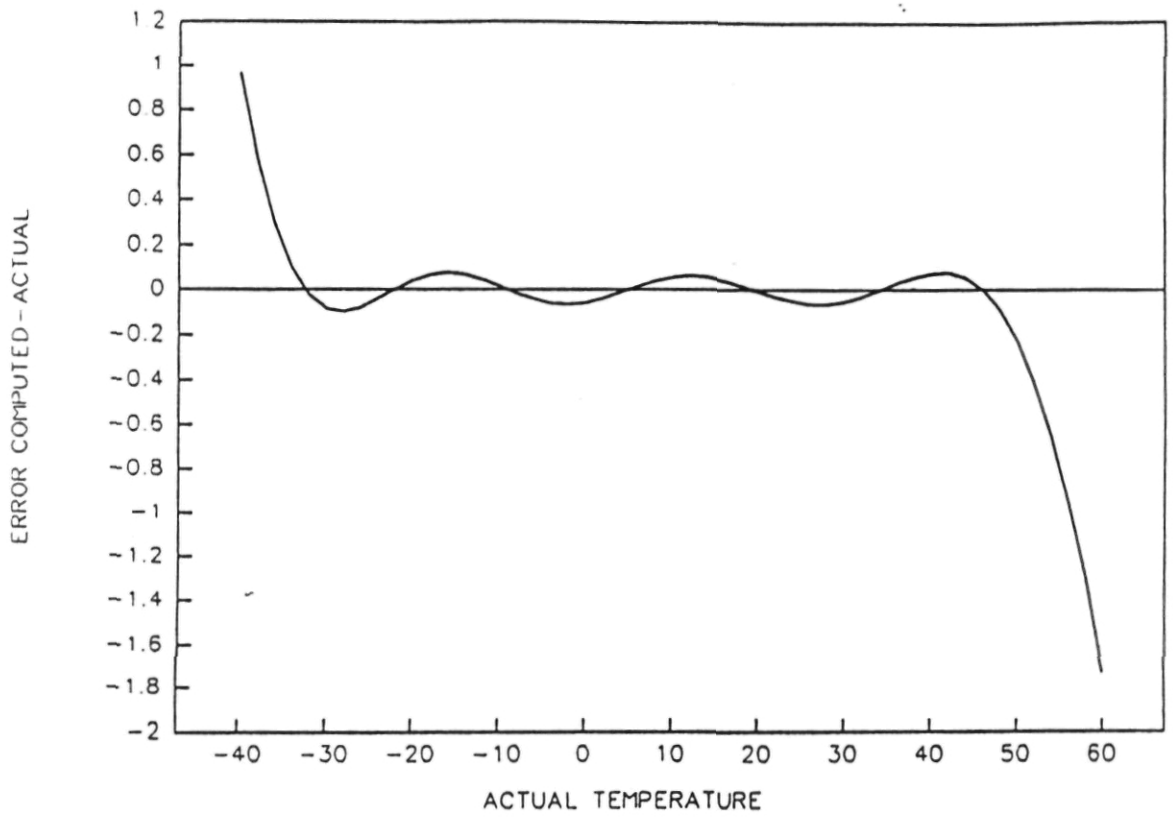


FIGURE 1. 107 Probe Polynomial Error Curve

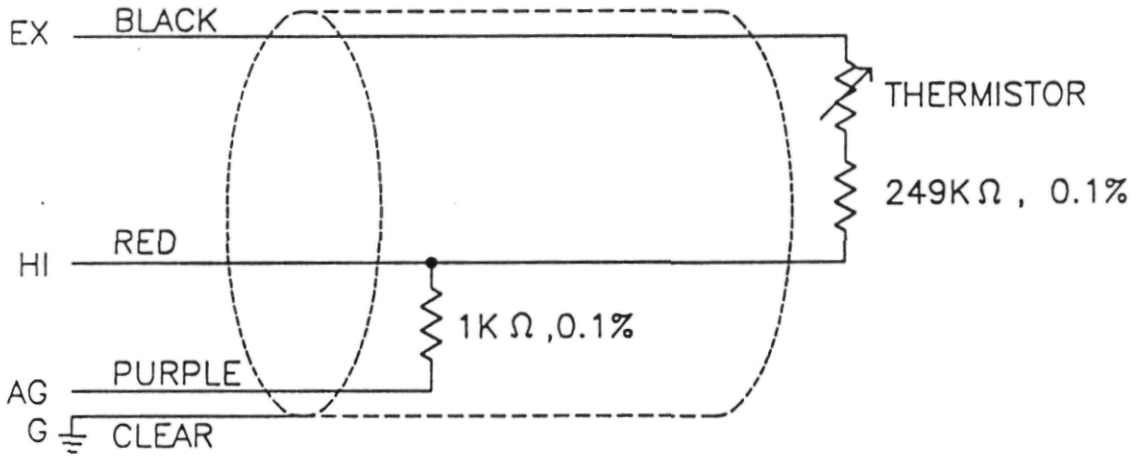


FIGURE 2. 107 Probe Schematic

4. PROGRAMMING

Instruction 11 is used to measure the 107 Probe. This instruction provides AC excitation, makes a single ended voltage measurement, and calculates the temperature in degrees Celsius with a fifth order polynomial.

Output in Celsius is obtained with a multiplier of 1 and an offset of 0. Fahrenheit can be obtained with a multiplier of 1.8 and an offset of 32.

5. INSTRUCTION 11 DETAILS

Reading this section is not necessary for general operation of the 107 Probe with Campbell Scientific's dataloggers.

Instruction 11 outputs a precise 4V AC excitation (2V with the CR10) and measures the voltage drop due to the sensor resistance. The thermistor resistance changes with temperature. Instruction 11 calculates the ratio of voltage measured to voltage excitation (V_S/V_X) which is a direct function of resistance, as shown below.

$$V_S/V_X = f(R_S) = R_f/(R_S+R_f) = 1000/(R_S+250000)$$

where, V_S/V_X = ratio of measured to excitation voltage,
R_f = fixed resistance,
and, R_S = sensor resistance.

Instruction 11 then calculates temperature using a fifth order polynomial equation developed by correlating V_S/V_X with temperature. The polynomial coefficients are given in Table 2; input to this equation is $(V_S/V_X)*8000$.

Table 2. Polynomial Coefficients

Coefficient	Value
C_0	-53.4601
C_1	9.08067
C_2	-8.32569×10^{-01}
C_3	5.22829×10^{-02}
C_4	-1.67234×10^{-03}
C_5	2.21098×10^{-05}

Table 3 displays resistance and datalogger output at several sensor temperatures.

TABLE 3. Temperature, Resistance, and Datalogger Output

TEMPERATURE °C	RESISTANCE OHMS	OUTPUT °C
-40.0	4015500	-39.0
-38.0	3503500	-37.4
-36.0	3062000	-35.7
-34.0	2680400	-33.9
-32.0	2350200	-32.0
-30.0	2064000	-30.1
-28.0	1815500	-28.1
-26.0	1599400	-26.1
-24.0	1411100	-24.0
-22.0	1246900	-22.0
-20.0	1103400	-20.0
-18.0	977910	-17.9
-16.0	867910	-15.9
-14.0	771370	-13.9
-12.0	686530	-12.0
-10.0	611870	-10.0
-8.0	546070	-8.0
-6.0	488000	-6.0
-4.0	436680	-4.1
-2.0	391270	-2.1
0.0	351020	-0.1
2.0	315320	2.0
4.0	283600	4.0
6.0	255390	6.0
8.0	230260	8.0
10.0	207850	10.1
12.0	187840	12.1
14.0	169950	14.1
16.0	153950	16.0
18.0	139610	18.0
20.0	126740	20.0
22.0	115190	22.0
24.0	104800	23.9
26.0	95447	25.9
28.0	87022	27.9
30.0	79422	29.9
32.0	72560	32.0
34.0	66356	34.0
36.0	60743	36.0
38.0	55658	38.1
40.0	51048	40.1
42.0	46863	42.1
44.0	43062	44.1
46.0	39605	46.0
48.0	36458	47.9
50.0	33591	49.8
52.0	30976	51.6
54.0	28590	53.4
56.0	26409	55.1
58.0	24415	56.7
60.0	22590	58.3

Installation and Operation Manual

Harmsco® Hurricane Filters

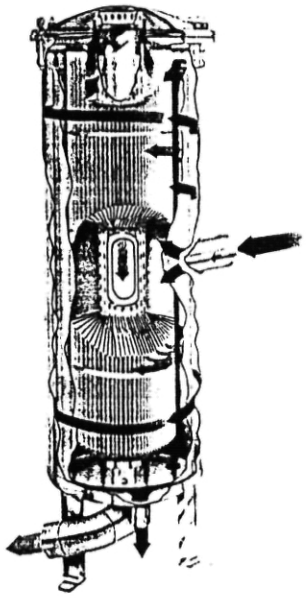
General

Harmsco Hurricane Filters provide exceptionally long filter runs, reduced maintenance and lower filtration costs when used as combination centrifugal separator and cartridge filter or in conventional filtration applications.

How They Work

Centrifugal Separation to Remove Dense Particles from Liquids

Liquid enters the Hurricane filter's outer chamber ***tangentially,*** producing a ***rotational flow.*** This flow pattern creates a ***centrifugal force*** which is used to separate dense particles such as sand, rust, grit and metal fines from liquids. Heavy particles drop to the bottom of the filter's outer chamber where they are discharged manually, automatically or continuously. With the dense particles removed, liquid and the light solids rise up, over and into an *inner* chamber where the rotational flow is continued.



Up-flow Cartridge Filtration and Angled Pleats for Light-weight Particle Removal

Lighter solids are removed in the filter's *inner* chamber by a proprietary filter cartridge made with deep, ***angled*** pleats which are directed ***toward*** the liquid's rotational flow. As forces of the liquid collide with the cartridge, the pleats "flutter" which distributes particulate evenly within the pleated area. Filter efficiencies are dramatically improved to provide longer filter runs and reduced filtration costs. Hurricane filter elements are available in a wide range of micron ratings and may be cleaned and reused in most applications and most micron ratings.

Models & Specifications

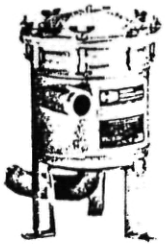
Three Hurricane Filter models are available for a wide range of applications. Models and specifications are as follows:

Specification	HUR-40-HP	HUR-90-HP	HUR-170-HP
Flow rate (GPM)	Up to 50	Up to 100	Up to 200
Filter area (pleated)	40 sq. ft.	90 sq. ft.	170 sq. ft.
Pipe size, inlet & outlet	2" NPT	2" NPT	2" NPT
Pipe size, drain	1" NPT	1" NPT	1" NPT
Filter height	21"	31"	41"
Filter diameter	13"	13"	13"
Floor space required	15" x 15"	15" x 15"	15" x 15"
Service height clearance	31"	51"	72"
Shipping weight (approx.)	40 lbs.	51 lbs.	64 lbs.

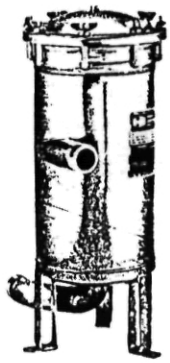
Features:

Product features include:

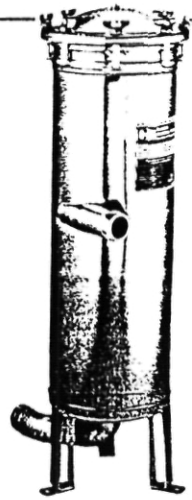
- 304 stainless steel filter housings
- Electro-polished for superior finish
- Resistant coatings available
- Fail-safe lids with individual studs for security
- Brass wing-nuts for convenience
- 90º elbow and 45º sweep on outlet for in-line vertical installation
- PVC standpipe for up-flow design
- Choice of cartridge included



HUR-40-HP



HUR-90-HP



HUR-170-HP

Temperature & Pressure Ratings

Hurricane Filters are rated for pressures to 150 psi and temperatures to 140ºF.

Sizing

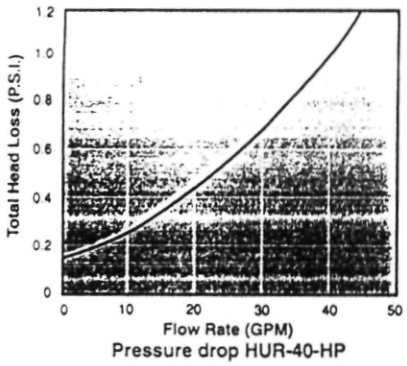
Use the chart shown below to size Hurricane Filters for your application:

Flow Rate	Recommended Model	Pleated Filter Area
Up to 50 GPM	HUR-40-HP	40 sq. ft.
Up to 100 GPM	HUR-90-HP	90 sq. ft.
Up to 200 GPM	HUR-170-HP	170 sq. ft.
Up to 400 GPM	HUR-170-HP (two filters*)	340 sq. ft. (two filters*)
Up to 600 GPM	HUR-170-HP (three filters*)	510 sq. ft. (three filters*)
Up to 800 GPM	HUR-170-HP (four filters*)	680 sq. ft. (four filters*)
Up to 1,000 GPM	HUR-170-HP (five filters*)	850 sq. ft. (five filters*)

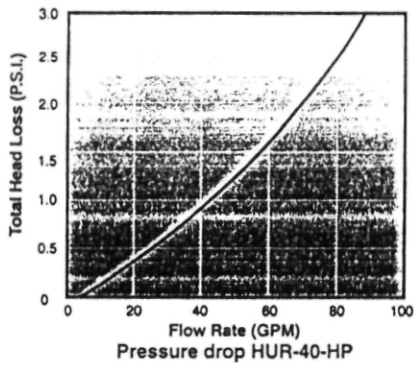
* Parallel installation with valves to isolate filters for service while other filters are operational.

Pressure Drop

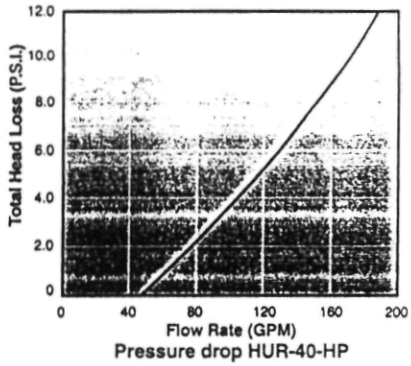
The total head loss data shown below was developed by NSF International and indicates pressure drop with Hurricane Filter and one micron filter cartridge in clean water.



Pressure drop HUR-40-HP

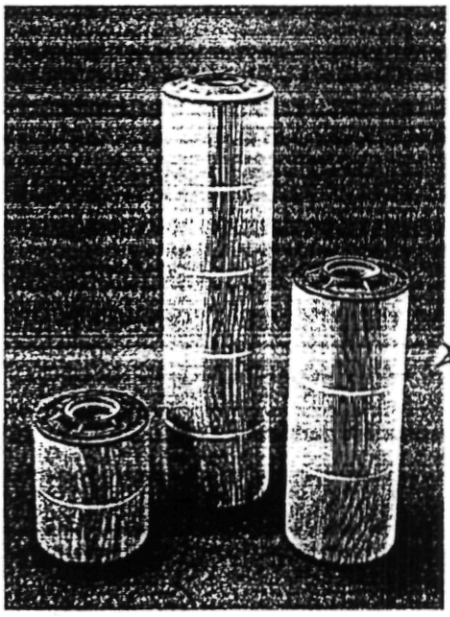


Pressure drop HUR-40-HP



Pressure drop HUR-40-HP

Harmsco Hurricane Replacement Cartridges



Hurricane replacement cartridges are available in a wide range of nominal micron ratings, shown below. Cartridges are rated for temperatures to 140ºF and may be used to separate solids in liquids with a pH of 3 to 11. Packaged one element per carton.

Filter Model	Cartridge Product Code	Nominal Micron	Cartridge dimensions L x	OD x	ID	Ship wt./ctn. (One cartridge)
HUR-40-HP	HC-40-0.35	0.35	9 5/8"	7 3/4"	3" FPT	4 lbs.
	HC-40-1	1	9 5/8"	7 3/4"	3" FPT	4 lbs.
	HC-40-5	5	9 5/8"	7 3/4"	3" FPT	4 lbs.
	HC-40-20	20	9 5/8"	7 3/4"	3" FPT	4 lbs.
	HC-40-50	50	9 5/8"	7 3/4"	3" FPT	4 lbs.
HUR-90-HP	HC-90-0.35	0.35	19 1/2"	7 3/4"	3" FPT	7 lbs.
	HC-90-1	1	19 1/2"	7 3/4"	3" FPT	7 lbs.
	HC-90-5	5	19 1/2"	7 3/4"	3" FPT	7 lbs.
	HC-90-20	20	19 1/2"	7 3/4"	3" FPT	7 lbs.
	HC-90-50	50	19 1/2"	7 3/4"	3" FPT	7 lbs.
HUR-170-HP	HC-170-0.35	0.35	30 3/4"	7 3/4"	3" FPT	10 lbs.
	HC-170-1	1	30 3/4"	7 3/4"	3" FPT	10 lbs.
	HC-170-5	5	30 3/4"	7 3/4"	3" FPT	10 lbs.
	HC-170-20	20	30 3/4"	7 3/4"	3" FPT	10 lbs.
	HC-170-50	50	30 3/4"	7 3/4"	3" FPT	10 lbs.

Hurricane Cartridge Cleaning Instructions

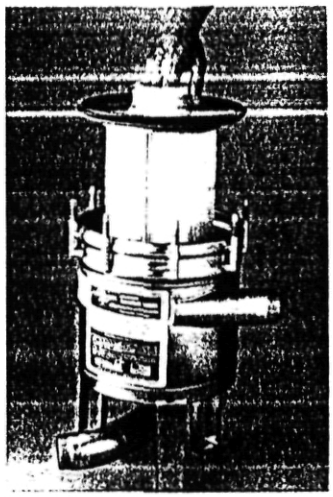
Hurricane cartridges are made with Polyester Plus,™ a proprietary blend of polyester fibers which can be cleaned in most applications and micron ratings to make Hurricane filter elements reusable! For best results follow the directions described below:

When Cartridge Cleaning is Possible

Clean cartridge when pressure differential is 12 psi above start-up differential.

Non-cleanable Applications

Replace cartridge when pressure differential is 25 psi above start-up differential or when flow has diminished to an unacceptable level, indicating cartridge is at capacity.



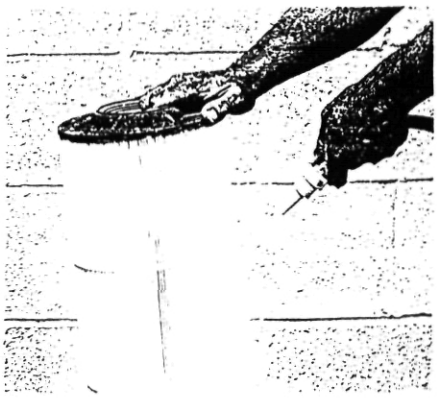
Cartridge Removal

To remove filter cartridge, drain filter housing. Remove wing-nuts and lid. Hold cross-bar in retainer nut and pull upward to remove filter cartridge and top plate from filter housing. Follow cleaning instructions described below.

Lid Replacement

Replace wing-nuts systematically, rotating around filter. "Finger tight" is normally sufficient. However, in extreme duty applications it may be necessary to tighten to 75 inch lbs. of torque. Over-tightening can cause damage to rim gasket.

NOTE: Pressure gauges are recommended to indicate when cartridge cleaning or replacement is necessary.



CAUTION: Do not rinse cartridges with acid until oils and organic matter are removed. Use detergent first and follow with acid bath for mineral removal. Flush cartridges with water after muriatic or tri-sodium phosphate baths.

Cartridge Cleaning in Aqueous Applications

For best results clean cartridge with pressure nozzle using standard hose. Direct spray at an angle to remove particulate (see photo). Follow these directions to remove oils, organic matter, algea and mineral deposits.

OILS: Soak cartridge in a solution of tri-sodium phosphate or similar strong detergent (2 lbs. to ten gallons of water). Soak up to twelve hours for best results. Rinse after bath.

ORGANIC MATTER, ALGEA: Use tri-sodium phosphate solution as described above, plus 1 pint of liquid chlorine to kill organic matter and algea. Soak cartridge one hour or longer until surface is no longer "slippery". Rinse after bath.

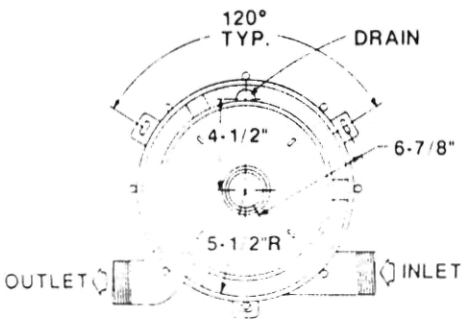
CALCIUM, MINERAL DEPOSITS: Follow directions for "oils" described above. Soak cartridge for approximately ten minutes in a solution of one part of muriatic acid to twenty parts of water. Rinse cartridge thoroughly with water.

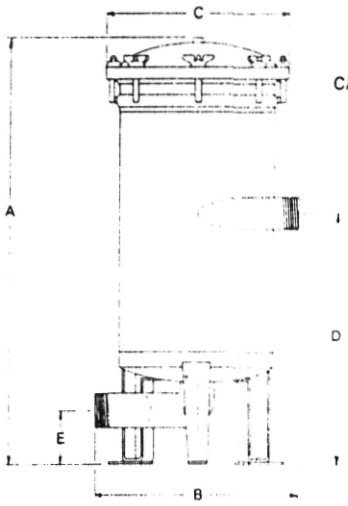
When Cartridge Cleaning is Not Possible:

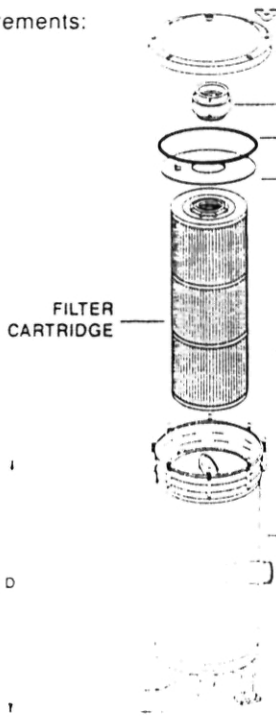
Generally, it is not possible to clean Hurricane filter cartridges when filtering petroleum-base liquids, toxic substances, and one and below micron applications.

Dimensions — The following drawing is provided for engineering requirements:

Model	A	B	C	D	E
HUR-40-HP	19 1/2"	14 3/8"	13"	12 9/16"	3 3/4"
HUR-90-HP	29 7/8"	14 3/8"	13"	17 5/8"	3 3/4"
HUR-170-HP	40 1/2"	14 3/8"	13"	27 1/2"	3 3/4"







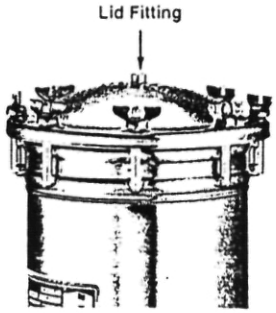
Cartridge Sub-assembly

Prior to installing cartridge in filter, place top plate on top of cartridge with clip upward. Thread on retainer nut securely for proper seal.

Installation

Install filter using 2" couplers for inlet and outlet with 1" coupler for drain pipe. Shut-off valves should be installed on inlet, outlet and on drain pipe to be able to service the filter and isolate it when necessary. Pressure gauges are also recommended before and after the filter to easily calculate the pressure differential and to know when cartridge should be cleaned or replaced. Threaded flanged fittings for inlet and outlet are available by special order.

1/4" FPT Lid Fitting



One-quarter inch FPT fittings are installed in Hurricane Filter lids for a number of customer supplied options, including petcock for pressure relief, pressure gauge, sensor, thermocoupler, etc. This fitting should be plugged at time of installation if one of these options are not installed.

Harmsco Inc. Industrial Filters Limited Warranty

1. Harmsco, Inc. warrants its line of Industrial Filters to be free of defects in material and workmanship for a period of one year from the date of installation.

2. ***THIS WARRANTY EXCLUDES THE FOLLOWING:***

   A. Any fresh water unit installed for salt water use.

   B. Damage caused by improper installation, operation or care.

   C. Chemical attack.

   D. Rubber type parts and normal wear items i.e.: "O" rings, rim gaskets, wing-nuts, pipe caps, holding rods.

   E. Any costs of labor or expenses expended in the removal and/or installation of Unit, or any surrounding device.

   F. Damage caused by galvanic or electrolytic attack.

   G. The altering of, or removal of, the Harmsco, Inc. information label.

3. Service under this warranty is to be provided by the distributor who sold the unit to the user. If the distributor is unable to provide warranty service, contact:

   Harmsco, Inc., P.O. Box 14066,
   North Palm Beach, Florida 33408, U.S.A.
   Phone: (407) 848-9628 • Fax: (407) 845-2474

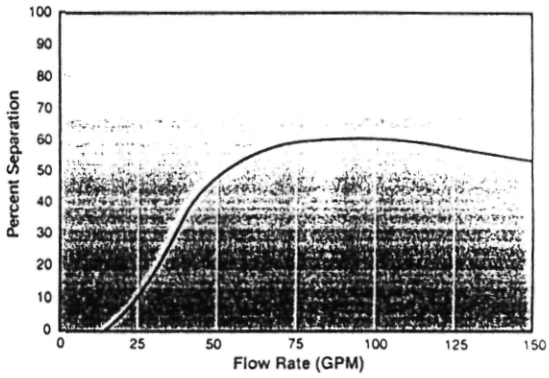
A Returned Goods Authorization (RGA) number must be received from the above office and placed on all shipments to and correspondence with Harmsco, Inc. Please be prepared with the following information: **1.** Model number and serial number **2.** Date of installation **3.** Name of installer **4.** Nature of problem **5.** Your address and telephone number.

MADE IN U.S.A.

Particle Separation

Particle separation with Hurricane filters is influenced by particle weight and flow rate. For optimum separation, the drain valve should be opened routinely by hand or automatically using a timer actuated valve. Automatic purge valves are not available from Harmsco. However, for more information regarding this equipment, please contact the Authorized Harmsco Distributor in your area.

The data shown below was developed through tests conducted with Hurricane filters and twenty micron filter cartridges to determine optimum flow rates for particle separation. Sand was used as the test particulate with a specific gravity of 2.6 relative to water at 1.0. This data is provided for general sizing purposes only. Results vary and depend on the particulate being filtered, viscosity and other variables.



Tests indicate the separation performance of all three Hurricane models were essentially the same up to the rated flow rate of each model.

Parts List

Hurricane filter parts and components are listed below:

Part No.	Material	Description
550-E	EPDM	Rim gasket to seal filter
905	PVC	Retainer nut for filter cartridge
309	Stainless steel	Top plate
312	PVC	Retainer nut insert
530-AC	Stainless steel	Lid with vent
316	PVC	Standpipe for HUR-40-HP
317	PVC	Standpipe for HUR-90-HP
315	PVC	Standpipe for HUR-170-HP
202-B	Brass	Wing-nut
320-A	Stainless steel	Outer vessel HUR-40-HP
321-A	Stainless steel	Outer vessel HUR-90-HP
302-A	Stainless steel	Outer vessel HUR-170-HP
318	Stainless steel	Inner vessel HUR-40-HP
319	Stainless steel	Inner vessel HUR-90-HP
300	Stainless steel	Inner vessel HUR-170-HP
329	CPVC	Inner vessel isolator
330	Stainless steel	Screw ¼" x ½" for isolator
Options:		
550-B	Buna-N	Rim gasket to seal filter
550-V	Viton	Rim gasket to seal filter
327	Stainless steel	2" Flange fittings (set of 2)

Patented Dec. 29, 1992; No. 5,174,896. Additional patents pending

Available from:

Toll Free: **(800)-327-3248** • Fax: **(407) 845-2474**
Export: (407) 848-9628

Harmsco® Industrial Filters
P.O. Box 14066 / North Palm Beach, FL 33408

 Printed in U.S.A. Lit. No. 410M-9/93-5000

Cleaning Instructions

Normal cleaning procedure. *Normal cleaning is done by using a* **pressure nozzle on the end of your garden hose.** *Direct jet spray* **at cartridges on an angle to remove dirt.**

Special cleaning procedures. **To be used only when normal procedure is insufficient to return cartridge to normal filter runs.**

1 *Removing Oils From Cartridges. If oils coat cartridges and cause reduced flow, this material may be removed by soaking cartridges in a solution of 2 lb. tri-sodium phosphate (or any similar strong detergent) to 10 gallons of water. Usually 12 hours soaking time will break oil coating from cartridge. Tri-sodium phosphate is available at most hardware stores, super markets, or janitorial supply houses. Repeat Normal Cleaning Procedure.*

2 **Removing Algae From Cartridges.** If algae coats the cartridges and cause reduced flow, soak cartridges in a solution of 2 lb. tri-sodium phosphate (or any similar strong detergent) to 10 gallons of water. Add 1 pint of swimming pool chlorine or 1 quart of laundry bleach to kill the algae. Soak for one hour. Check pool chemistry for cause of algae growth.

3 **Removing Calcium Or Mineral Deposits.** ***Caution*** Do not use muriatic acid on cartridges until all oils have been removed as in step #1 above. Make sure all detergent has been thoroughly rinsed from cartridges.

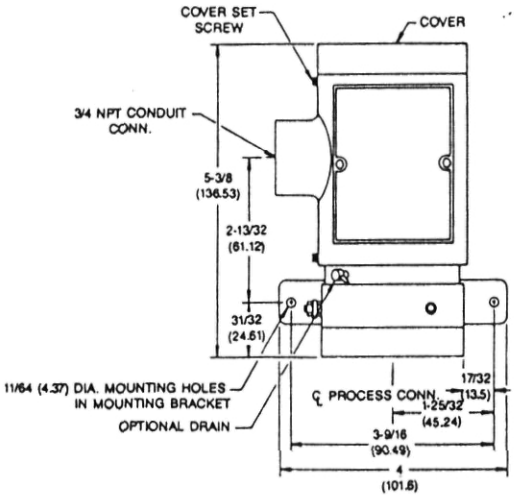
If calcium deposits are present, perform operation #1 above. Rinse—then in a solution of 1 part muriatic acid to 20 parts water soak until bubbling action stops. Use a plastic garbage container or similar vessel. Check pool chemistry for high PH or Alkalinity. Repeat Normal Cleaning Procedure.

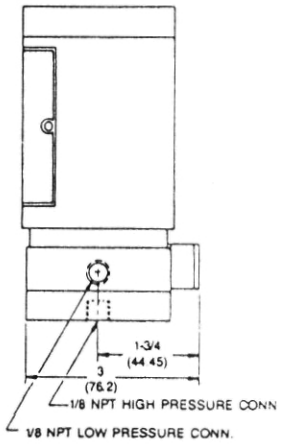
SERIES H3 DIFFERENTIAL PRESSURE SWITCHES EXPLOSION-PROOF, WEATHERPROOF

1-0734-1

Installation and Operating Instructions

Patent No. 4,827,095





Series H3 Differential Pressure Switches actuate one or two single pole, double throw (SPDT) snap switches in response to increasing or decreasing pressure of compatible gases or liquids. Four field adjustable operating ranges are available allowing set-points up to 200 PSID. All models are suitable for hazardous locations and also include weatherproof housings as detailed in the chart below. Read and understand instructions completely before proceeding with installation or operation.

MODEL NUMBER DEFINITIONS

H3 ① – ② ③ ④ – ⑤

① **Wetted Materials**
- A – Aluminum/Nitrile
- S – 316 SS/Viton

② **Operating Range**

1 – 10 - 180 In. W.C.	(.025 - .46 Kg/cm²)
2 – .5 - 15 PSID	(.035 - 1.05 Kg/cm²)
3 – 5 - 70 PSID	(.35 - 4.92 Kg/cm²)
4 – 10 - 200 PSID	(.70 - 14.06 Kg/cm²)

③ **Circuit**
- S – SPDT
- D – DPDT

④ **Electrical Connections**
- C – Terminal block(s)
- L – Wire leads

⑤ **Options**
- MV – Gold contacts
- DR – Drain/Breather

PHYSICAL DATA

Maximum Temperature:	220°F
Maximum Pressure:	1500 PSI
Pressure Connections:	1/8" FNPT
Electrical Rating:	SPDT or optional DPDT contacts rated 5A @ 125/250 VAC, 5A res., 3A ind. @ 30 VDC. MV (gold contact) option for dry circuits rated 1A @ 125 VAC, 1A res. or 0.5A ind. @ 30 VDC
Wiring Connections:	18 AWG × 18" leads. Internal terminal blocks optional.
Conduit Connection:	3/4" NPT
Set Point Adjustment:	Screw type, field adjustable.
Housing:	Aluminum
Body:	Aluminum or 316 SS
Diaphragm:	Nitrile or Viton
Weight:	2¼ lbs.

HAZARDOUS LOCATION/WEATHERPROOF RATINGS

MODEL	UL	CSA	CENELEC
H3 _ – _ _ C	Cl.I, Gr.B, C & D Cl.II, Gr.E, F & G NEMA 4X	Cl.I, Gr.B, C & D Cl.II, Gr.E, F & G NEMA 4	EExd IIc T6 IP 56
H3 _ – _ _ L	Cl.I, Gr.B, C & D Cl.II, Gr.E, F & G NEMA 4X	Cl.I, Gr.B, C & D Cl.II, Gr.E, F & G NEMA 4	—
H3 _ – _ _ C-DR	Cl.I, Gr.B, C & D Cl.II, Gr.E, F & G NEMA 3	—	EExd IIc T6 IP 54
H3 _ – _ _ L-DR	Cl.I, Gr.B, C & D Cl.II, Gr.E, F & G NEMA 3	—	—

INSTALLATION

1. **LOCATION:** Select a location where the temperature limit of 220°F (104°C) will not be exceeded. Locate the switch as close as possible to the pressure source for best response. Longer lengths of tubing will not affect the accuracy of the actuation point but can increase response time slightly.
2. **MOUNTING:** Avoid mounting surfaces with excess vibration which could cause false actuation when pressure is near set-point. Attach switch with two 3/16" screws or bolts (not included) through mounting bracket. Normal position is with housing vertical.
3. **PRESSURE CONNECTION:** Connect source(s) of pressure, vacuum or differential pressure to the 1/8" NPT ports as follows:
   A. **Differential Pressures** – Connect higher pressure to High Pressure port (bottom) and lower pressure to Low Pressure port (side).
   B. **Pressure Only** – connect a single positive pressure to High Pressure port on bottom and leave Low Pressure port on side vented to atmosphere.
   C. **Vacuum Only** – Connect a single negative (vacuum) pressure to Low Pressure port on side and leave High Pressure port on bottom vented to atmosphere.

CONTINUED ON REVERSE

4. **ELECTRICAL CONNECTIONS:** Either one or two SPDT snap switches are provided with normally open contacts closing and normally closed contacts opening when pressure or vacuum increases beyond the set-point.

A. Wire in accordance with local electrical codes.

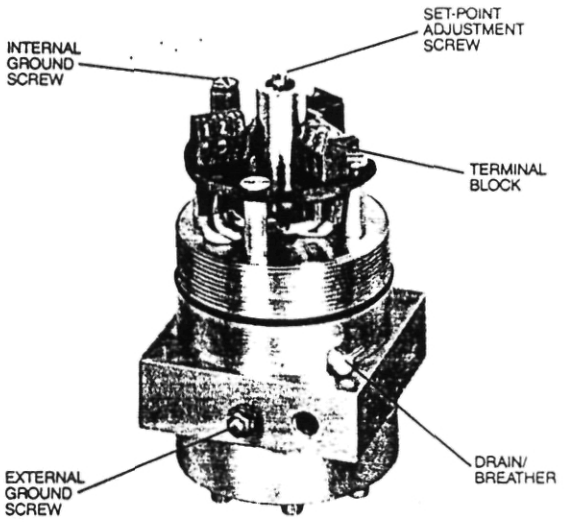
B. **Wire lead models** – Thread wires through conduit and connect to leads from snap switch(es).
Black = Common, Red = Normally closed, Blue = Normally open

C. **Terminal block models** – Loosen screws on terminal block(s), insert stripped and tinned wires in side openings and tighten screws. For Cenelec approved installation, cable should enter enclosure housing through an approved Ex cable gland (not supplied).
Black = Common, Red = Normally closed, Blue = Normally open

D. **Ground Screws** – Two grounding connections are furnished; one inside housing with green headed machine screw and one on exterior with threaded stud and nut. Use either one.

Replace cover after wiring connections are complete.

CAUTION: MAKE SURE CONDUIT OR CABLE ARE PROPERLY SEALED. ELECTRICAL COMPONENTS MUST BE KEPT FREE OF MOISTURE, INCLUDING CONDENSATION, AT ALL TIMES. TO PREVENT IGNITION OF HAZARDOUS ATMOSPHERE, DISCONNECT THE DEVICE FROM THE SUPPLY CIRCUIT BEFORE OPENING. KEEP ASSEMBLY TIGHTLY CLOSED WHEN IN OPERATION.



ADJUSTMENT

1. To change the set-point, connect tubing or piping from the high pressure port on bottom to one leg of a tee. Connect the second leg to a pressure gage of known accuracy and in an appropriate range. The third leg should be connected to a controllable pressure source.
2. Connect a volt/ohm meter or other circuit tester to snap switch to indicate when switching occurs.
3. Slowly apply pressure to the system and note the pressure at which switching occurs. If adjustment is necessary, turn the adjustment screw (located internally at center next to snap switch) clockwise to raise or counterclockwise to lower the actuation point. When the required setting has been reached, exercise the switch through two or three additional cycles to verify consistent operation.

MAINTENANCE

The moving parts of these switches need no maintenance or lubrication. The set-point is the only user adjustment. On models with optional drain fitting, periodically rotate small captive screw from side to side several times to keep drain path clear. Units in need of repair should be returned to the factory prepaid.

W.E. ANDERSON DIV., DWYER INSTRUMENTS, INC.
P.O. Box 358
Michigan City, IN 46360
Phone: 219/879-8000 Telex: 25916
Fax: 219/872-9057

LITHO IN USA 8/91
FR 81-440700-00

UC-22 PRESSURE TRANSDUCER & JUNCTION BOX

APPLICATION NOTE

1 (a) Where the supply voltage engraved on the transducer body states "... V d.c." it is VERY IMPORTANT to use the STATED SUPPLY VOLTAGE AND POLARITY since the transducer uses an active compensation circuit.

1 (b) Where the supply voltage engraved on the transducer body states "... VOLTS" then the compensation circuit is passive and any supply voltage up to a maximum of 12 VOLTS may be used. Transducer sensitivity and current consumption will be proportional to supply voltage.

2 Current consumption will not be greater than 15mA for 1 (a) with stated supply voltage and 10mA for 1 (b) with 10 Volts supply.

3 Zero offset (normally less than 3mV) can be nulled using a 250 Kohm potentiometer across the output terminals with the wiper connected via 250 Kohm to the negative supply.

4 For best temperature stability, transducer must have a load impedance of greater than 50 Kohm.

5 A calibration resistor may be used. For positive output, connect Rcal between negative output terminal and negative supply. For negative output, connect Rcal between positive output terminal and negative supply. Note that calibration output can be temperature-sensitive. In case of difficulty refer to supplier.

6 If a power supply earth is used, it is preferable to earth the positive side.

7 Following conventional practice, the cable screen is not connected to the transducer body. (On some PDCR 22 devices the flying green lead is connected to cable screen and may be connected to the solder post on the back of the transducer).

CALIBRATION CERTIFICATE

1-0741-3-101

Calibration date:	9/17/93	WO: D1147
Transducer type:	PDCR 940-1173	
Serial Number:	448574	
Range:	100 psi g	
Supply:	10 Volts	
Sensitivity:	99.79mV	
Non-linearity & Hysteresis:	±0.1% BSL	
Temperature operating range:		
Temperature compensated range:	-2°C to +30°C	
Temperature error band:	±0.3%	
Thermal zero shift:		
Thermal sensitivity shift:		

Electrical connection

Supply positive:	RED	-	Monitor ORANGE
Supply negative:	WHITE	-	BLACK
Output positive:	YELLOW		
Output negative:	BLUE		
Screen:	CONNECTED TO BODY		

Notes:

190 ft. of depth cable

CC2

Druck Incorporated
4 Dunham Drive, New Fairfield, CT 06812
Tel. (203) 746-0400 Telex: 643118
FAX: (203) 746-2494

FAX MEMO

1-0741-3-101

cc J

DRUCK INCORPORATED

4 Dunham Drive
New Fairfield
Connecticut 06812

TEL: (203) 746-0400
FAX: (203) 746-2494
TELEX: 643116

MESSAGE NO. ____

DATE: 11.2.93

TO: Jim Bowes

NO. OF PAGES (Incl. this page) ____

COMPANY NAME: Johnson Co.

FAX NO. 802-229-5876

FROM: Linda Barbarotta

COPY TO: ____

SUBJECT: Copy of cal Data requested

S/N S18835
WO J04409
TYPE 940
7.0 BAR
VSUP 10.0
ZOS 0.354
FRO 99.76

PSI	DEV%
0	0.01
0	0.02
20	-0.01
40	-0.02
60	-0.02
60	-0.01
80	-0.01
100	0.02
100	0.02
MAX	0.02

ZERO

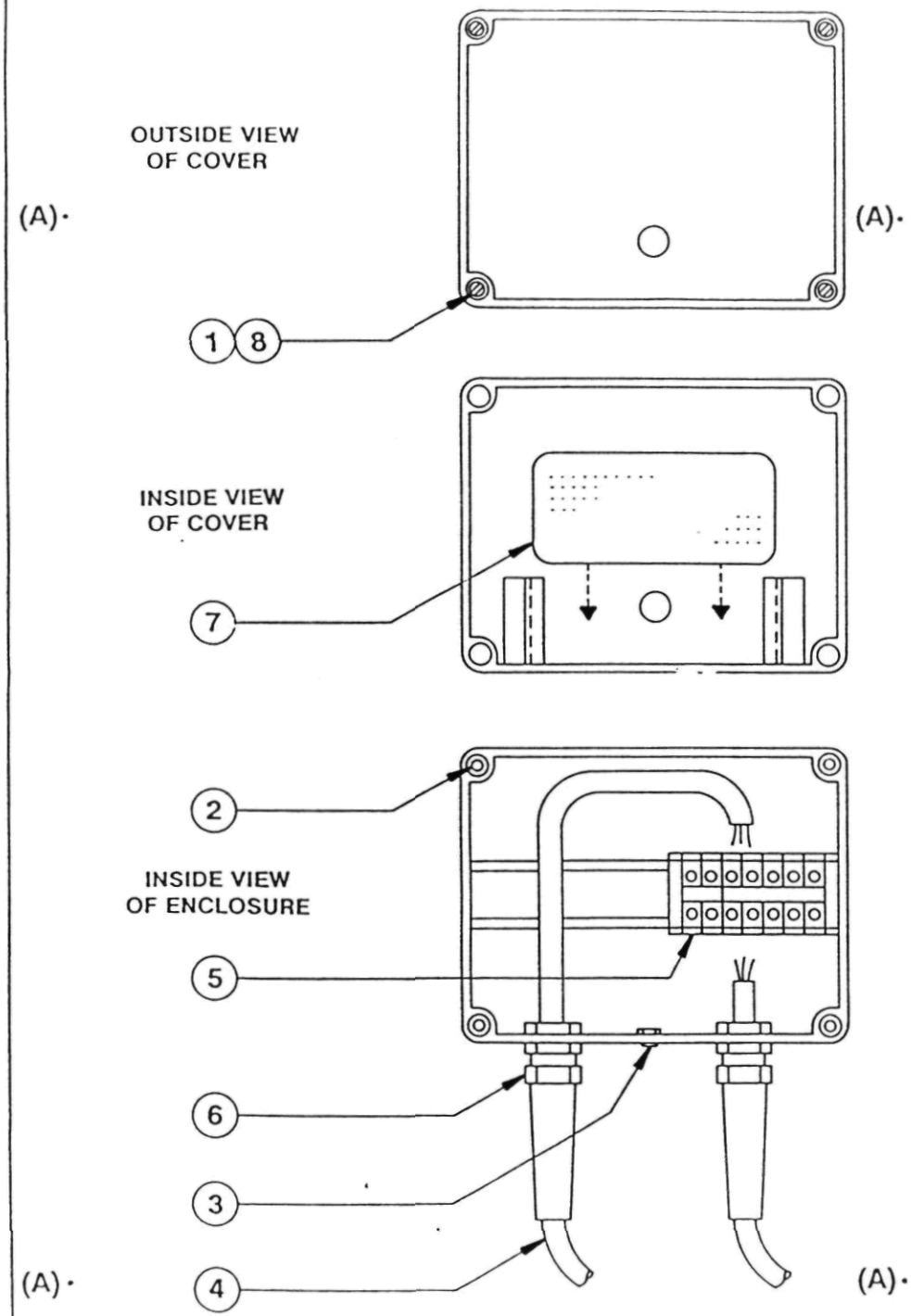
3	0	-0.04
2	15	0.01
1	30	0.00

SPAN

3	0	0.05
2	15	0.04
1	30	0.00

TEB
S/N 518835
FROM 0
TO 30
TEB 0.03%

RECEIVED
NOV 3 1993
THE JOHNSON CO., INC.
MONTPELIER, VERMONT



STE-110 ENCLOSURE ASSEMBLY

1. Loosen (4) corner screws and remove cover.
2. Mounting holes accept #8-32 screws (use points (A) for template).
3. Be sure vent is always facing downward and DO NOT BLOCK.
4. Attach loose sections of strain reliefs and push cable through. (Strain reliefs will accept customer supplied cable diameters from .231 to .394 inches).
5. Connect wires to desired positions on terminal strip.
6. Tighten strain relief nut enough so wire cannot be pulled out easily.
7. Remove DRI-CAN from package and insert into slots with window facing toward hole.
8. Install cover and tighten screws.

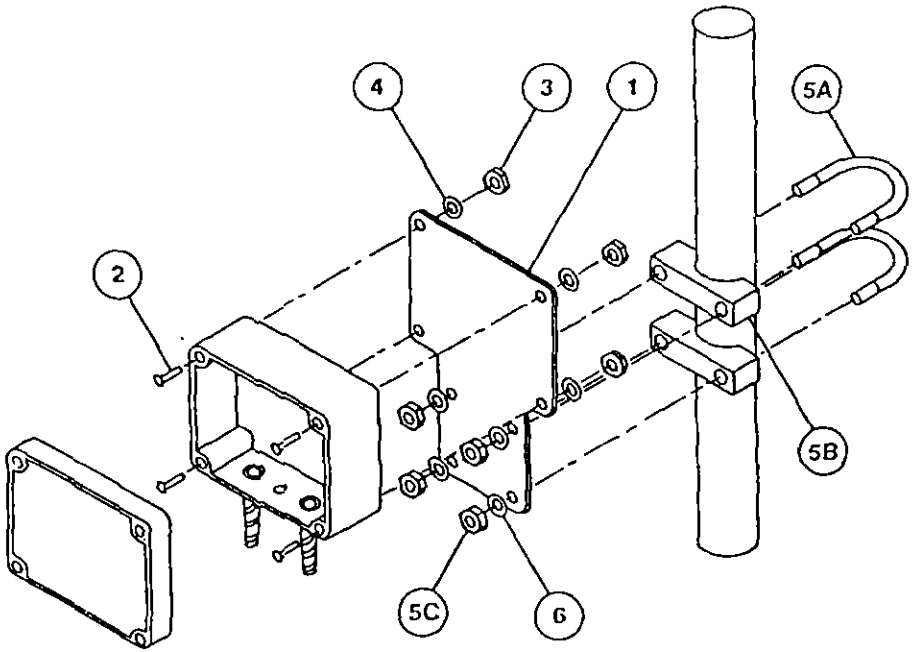
DRI-CAN REGENERATION PROCEDURE

The DRI-CAN saturation point is reached when it turns pink. Heating the DRI-CAN in a vented oven at 300°F for approximately 3 hours, or until the deep color returns, will restore its absorbent capabilities.

INSTALLATION NOTES

- Precautions must be taken to ensure moisture does not enter the sensor cable or STE-110 during installation or DRI-CAN replacement.
- The desiccant module at the end of the sensor cable should only be removed immediately prior to termination of wires and installation of the STE-110 cover.
- The user must establish a pattern for replacement of the DRI-CAN to avoid it becoming saturated. The replacement period will vary according to local atmospheric conditions.
- When the DRI-CAN is exhausted, immediately replace with a new or regenerated canister.
- Modifications or damage of enclosure will void warranty of the STE-110 and sensor.

STE-110 PIPE MOUNTING ASSEMBLY



ITEM	QUANTITY	PART DESCRIPTION
1	1	Pipe mounting plate
2	4	#8-32 x 3/4" lg. screw
3	4	#8-32 nyloc nut
4	4	#8-32 washer
5	2	U-bolt assembly (includes 5A, 5B & 5C)
5A	1*	3/8" U-bolt
5B	1*	U-bolt clamp
5C	2*	3/8" nut
6	4	3/8" washer

* Per Assembly

Druck

STE-110

SENSOR TERMINATION ENCLOSURE

INSTALLATION INSTRUCTIONS

Data Industrial®

Series 228 Metallic Tee Flow Sensors

The Data Industrial Series 228 flow sensors feature a six bladed impeller design with a proprietary non-magnetic sensing mechanism. The forward swept impeller shape provides higher, more consistent torque than four bladed impeller designs and is less prone to be fouled by water borne debris. The forward curved shape coupled with the absence of magnetic drag provides improved operation and repeatability even at lower flow rates. This is especially true where the impeller is exposed to metallic or rust particles found in steel or iron pipes. As the liquid flow turns the impeller, a low impedance square wave signal is transmitted with a frequency proportional to the flow rate. The signal can travel up to 2000' between the flow sensor and the display unit without the need for amplification. All sensors except irrigation versions are supplied with 20' of 2-conductor 20 AWG shielded U.L. type PTLC 105°C cable.

Series 228 Tee Sensors

The tee mounted flow sensors consist of a standard 220BR or 220SS mounted in a 2" or 2.5" tee.

Model 228B - brass/bronze sensor mounted in a bronze tee.

Model 228CB - brass/bronze sensor mounted in a cast iron tee.

Model 228CS - stainless steel sensor mounted in a cast iron tee.

Model 228SS - stainless steel sensor mounted in a stainless steel tee.

CE FM APPROVED CSA® Exia

228 Series Metal Tee Sensors Ordering Matrix (2" to 2½")

	Example:	2	28	BR	20	0	5	-	0	2	1	1
STYLE												
Tee Mounted Insert Sensor (2" and 2.5" only)			28									
MATERIAL												
Brass/Bronze				BR								
Stainless Steel (2" and 2.5" only)				SS								
Tee - Carbon Steel Sensor Brass				CB								
Tee - Carbon Steel Sensor Stainless Steel				CS								
Size												
2"					20							
2.5"					25							
Electronics Housing												
PPS						0						
ELECTRONICS												
Magnetic							2					
FM/CSA Approved							4					
Standard							5					
IR-Irrigation							6					
O-RING												
Viton®									0			
EPDM									1			
Buna N									8			
SHAFT												
Zirconia Ceramic										0		
Hastalloy C										1		
Tungsten Carbide										2		
Titanium										3		
Monel										5		
316 Stainless Steel										6		
Tantalum										7		
IMPELLER												
Nylon											1	
Tefzel®											2	
BEARING												
Pennlon												1
Tefzel®												2
Teflon®												3

Viton®, Teflon®, Tefzel® are registered trademarks of Dupont Dow Elastomers

Data Industrial Corporation, 11 Industrial Drive, P.O. Box 740, Mattapoisett, MA 02739, Telephone: (508) 758-6390 Fax: (508) 758-4057
web site: www.dataindustrial.com email: sales@dataindustrial.com

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Specifications

Wetted Materials (except tees)
— See Ordering Matrix

Sensor Sleeve and Hex Adapter for 228BR and 228CB
— Sleeve: Admiralty Brass, UNS C44300; Hex Adapter: Valve Bronze, UNS C83600

Sensor Sleeve and Hex Adapter for 228SS and 228CS
— 300 Series Stainless Steel

Tee for 228BR
— Cast Bronze, Class 125 Per ASME B16.15, and Copper Coupling

Tee for 228SS
— Cast 316 Stainless, Class 150

Tee for 228CB and 228CS
— Cast Iron, Class 125 Per ASME B16.4

Temperature Ratings
— Standard Version:
221°F (105°C) continuous service
— Irrigation Version:
150°F (66°C) continuous service
— High Temperature Version:
285°F (140.6°C) continuous service
305°F (150°C) peak temperature
(limited duration)

Pressure

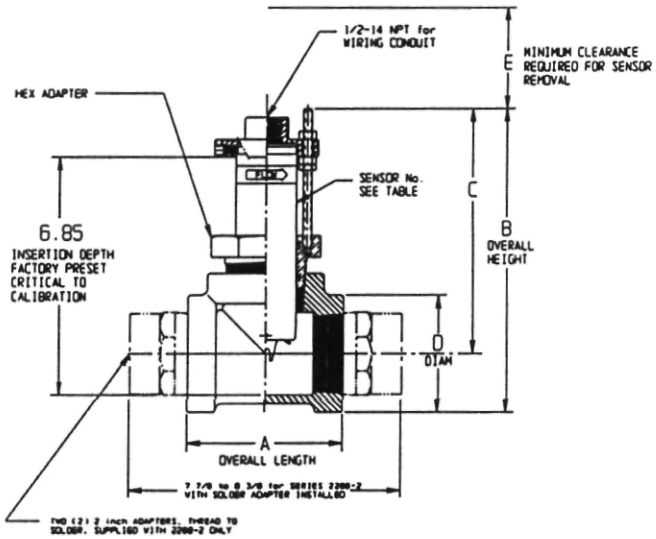
	At 100°F	At 300°F
228B	200 psi	165 psi
228CB	175 psi	140 psi
220SS	400 psi	325 psi

Recommended Design Flow Range
— 0.5 to 30 ft/sec

Accuracy
— ± 1.0% of full scale over recommended design flow range

Repeatability
— ± 0.3% of full scale over recommended design flow range

Linearity
— ± 0.2% of full scale over recommended design flow range



NOTE- DIMENSIONS "B" AND "C" MAY VARY +/- 1/4 inch, DEPENDING UPON MAKE-UP ON PIPE THREADS.

228CB-2.5	SEE MATRIX	71881T	2.5-8	4.88	9	7	4	6
228B-2.5	SEE MATRIX	71883T	2.5-8	4.75	8.78	7	3.56	6
228SS-2	SEE MATRIX	711338T	2-11.5	4.5	6.38	6.88	3	6
228CS-2	SEE MATRIX	71876T	2-11.5	4.5	8.57	6.88	3.38	6
228CB-2	SEE MATRIX	71876T	2-11.5	4.5	8.57	6.88	3.38	6
228B-2	SEE MATRIX	71879T	2-11.5	4.25	8.35	6.88	2.94	6
SERIES No COMPLETE	SENSOR No.	TEE No.	NPT	A	B	C	D	E

Transducer Excitation
— Quiescent current 600uA@8VDC to 35VDC max.
— Quiescent voltage (V_{high})
Supply Voltage -(600uA*Supply impedance)
— ON State (V_{Low}) Max. 1.2VDC@40mA current limit (15Ω + 0.7VDC)

Electrical Cable for Standard Sensor Electronics
— 20 feet of 2-conductor 20 AWG shielded U.L. type PTLC wire provided for connection to display or analog transmitter unit. Rated to 105°C. May be extended to a maximum of 2000 feet with similar cable and insulation appropriate for application.

Electrical Cable for IR Sensor Electronics
— 48 inches of U.L. Style 116666 copper solid AWG 18 wire w/direct burial insulation. Rated to 105°C.

Data Industrial®

Data Industrial Corporation, 11 Industrial Drive, P.O. Box 740, Mattapoisett, MA 02739, Telephone: (508) 758-6390 Fax: (508) 758-4057
web site: www.dataindustrial.com email: sales@dataindustrial.com

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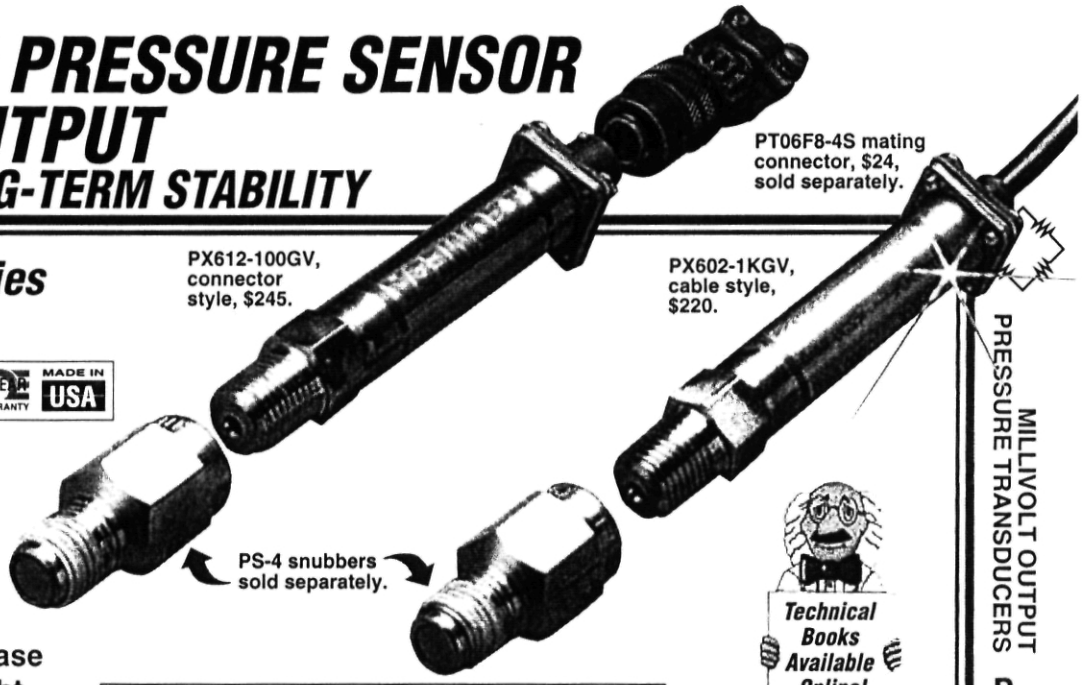
THIN-FILM PRESSURE SENSOR
100 mV OUTPUT
EXCELLENT LONG-TERM STABILITY

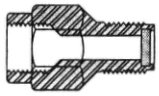
PX602/PX612 Series
0-15 to 0-20,000 psi
0-1.0 to 0-1379 bar

MADE IN USA

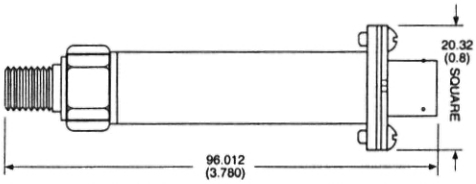
Starts at
$220



- All Stainless Steel Case
- Small and Lightweight
- NEMA 4 (IP65) Cable or Connector Models



¼ NPT Pressure Snubbers: $10
PS-4G = Gas **PS-4E** = Lt Oil
PS-4D = Dense Lq



Connections

Pin	Wire	
A	Red	+Exc
B	Green	+Out
C	Black	-Out
D	White	-Exc

SPECIFICATIONS

Excitation: 10 Vdc (5 to 10 Vdc limits)
Output: 0 to 100 mV @ 10 Vdc
Sensitivity: 10 mV/V
Input Impedance: 1500 Ω
Output Impedance: 100 Ω
Insulation Resistance: 100 MΩ @50 Vdc
Accuracy: ±0.4% BFSL
Hysteresis: ±0.2%
Repeatability: ±0.05%
Stability: ±1%/year
Zero Balance: ±1%
Durability: 100 million cycles
Operating Temp: -48 to 91°C (-55 to 195°F)
Compensated Temp: -29 to 82°C (-20 to 180°F)
Thermal Zero Effect: ±0.07% FS/°C
Thermal Span Effect: ±0.07% FS/°C
Proof Pressure:
15 to 2000 psi = 200%
3000 to 5000 psi = 150%
7500 to 20,000 psi = 120%
Burst Pressure:
15 to 2000 psi = 800%
3000 to 20,000 psi = 500%
Gages: Thin film polysilicon
Diaphragm: 17-4 PH stainless steel
Case: 300 Series stainless steel
Pressure Connection:
15 to 10,000 psi: ¼ NPT
15,000 and 20,000 psi: 9/16-18 UNF Aminco fitting
Electrical Connection: 0.9 m (36") braided-shield PVC cable or connector
Weight: 71 g (2.5 oz.) without cable
Response time: 5 ms
Construction: Sealed units (except PX602 ≤ 500 psi is vented to room)

MOST POPULAR MODELS HIGHLIGHTED!

To Order *(Specify Model Number)*

RANGE psi	RANGE bar	MODEL NO. [ ] Insert 0 or 1	PRICE PX602	PRICE PX612	COMPATIBLE METERS**
0 to 15	0 to 1.0	PX6[ ]2-015GV	$230	$260	DP41-S, DP25B-S, DP302-S
0 to 30	0 to 2.1	PX6[ ]2-030GV	230	260	DP41-S, DP25B-S, DP302-S
0 to 60	0 to 4.1	PX6[ ]2-060GV	220	245	DP41-S, DP25B-S, DP302-S
0 to 100	0 to 6.9	PX6[ ]2-100GV	220	245	DP41-S, DP25B-S, DP302-S
0 to 150	0 to 10.3	PX6[ ]2-150GV	220	245	DP41-S, DP25B-S, DP302-S
0 to 200	0 to 13.8	PX6[ ]2-200GV	220	245	DP41-S, DP25B-S, DP302-S
0 to 300	0 to 20.7	PX6[ ]2-300GV	220	245	DP41-S, DP25B-S, DP302-S
0 to 500	0 to 34.5	PX6[ ]2-500GV	220	245	DP41-S, DP25B-S, DP302-S
0 to 1000	0 to 68.9	PX6[ ]2-1KGV	220	245	DP41-S, DP25B-S, DP302-S
0 to 2000	0 to 138	PX6[ ]2-2KGV	220	245	DP41-S, DP25B-S, DP302-S
0 to 3000	0 to 207	PX6[ ]2-3KGV	220	245	DP41-S, DP25B-S, DP87
0 to 5000	0 to 345	PX6[ ]2-5KGV	220	245	DP41-S, DP25B-S, DP87
0 to 7500	0 to 517	PX6[ ]2-7.5KGV	220	245	DP41-S, DP25B-S, DP87
0 to 10,000	0 to 689	PX6[ ]2-10KGV	250	275	DP41-S, DP25B-S ,DP87
0 to 15,000	0 to 1034	PX6[ ]2-15KGV*	260	290	DP41-S, DP87
0 to 20,000	0 to 1379	PX6[ ]2-20KGV*	260	290	DP41-S, DP87

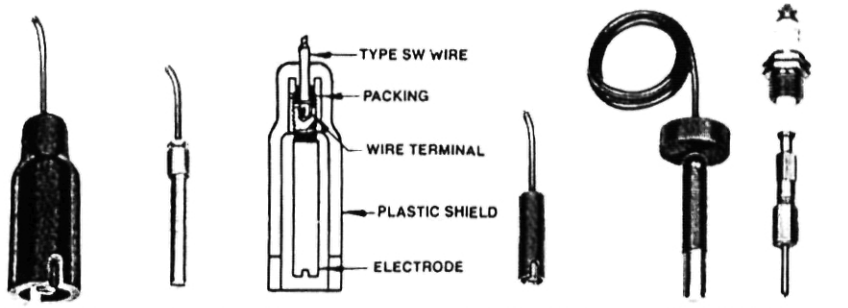
Comes with complete operator's manual.
** 15,000 and 20,000 psi models supplied with female Aminco fitting.*
*** See section D for compatible meters.*

Ordering Examples: PX612-100GV,** 100 psi connector-style transducer, **$245.** **PX602-100GV,** 100 psi cable-style transducer, **$220.** **DP41-S,** meter, **$545.** **PT06F8-4S,** mating connector (sold separately), **$24.** **PS-4,** snubber, **$10.

ACCESSORY

MODEL NO.	PRICE	DESCRIPTION
GE-2117	$23	Reference Book: Controller Tuning PID Without Math

WIRE SUSPENSION ELECTRODES



6013W1 or W2 E-1P WITH SHIELD | 6013W3 or W4 E-1P LESS SHIELD | E-1P CUT-AWAY | 6013W5 or W6 E-1S WITH SHIELD | 6013W7 to W13 13-064700 | PLUG WITH CONNECTOR

Wire suspension electrodes are designed for use in applications requiring long lengths, or where limited head room prevents installation of solid rod electrodes. They can be used with all holders except Type CE-2 & 3. Electrode Types E-1P and E-1S are for use in water and non-corrosive liquids. Type 13-064700 is designed for corrosive liquids and is available with a variety of rod materials. Types E-1P and E-1S electrodes with molded plastic shields can be used at temperatures up to 150°F and other electrodes up to 190°F.

Type E-1P-Shielded: This electrode is approximately 4" long and assembled in a molded plastic insulating shield 1 7/16" in diameter. Designed for general purpose use, it is ideal for elevated tanks, sewage pumping stations, and deep well installations.

Type E-1P — Less Shield: This electrode is intended for applications where space prevents the use of other electrodes and where vertical spacing between electrodes is 4" or more.

Type E-1S-Shielded: A 2" long electrode assembled in a molded plastic shield 9/16" in diameter. Ideal for use in submersible pump installations and other applications where little clearance is provided for installation.

Type 13-064700: This electrode is intended for corrosive liquids. It is 3" long made from a ½" diameter rod and available in any of the materials listed below. The type SW wire is attached at the factory and the connection is completely sealed with PVC and bonded to the insulation of the SW wire.

WIRE CONNECTOR: This adapter is necessary to attach the Type SW suspension wire to the ¼-20 female electrode holder connections. One is required for each wire suspension electrode used with electrode plugs, and Type E and Type AE-2 holders.

CATALOG NUMBER
6013 — C — BR

Material	
Brass *Old No. 12-038400*	BR
303 SS Old No. 12-043800	SS

Type SW Suspension Wire: Designed to provide maximum strength and insulation, Type SW wire should always be used with BIW wire suspension electrodes to assure that a watertight seal is accomplished by the packing in the electrode. The wire is single conductor 18 gauge, 41 strand copper with 4/64" vinyl insulation.

CATALOG NUMBER
6013 — SW — 10

Specify Length In Feet Old No. 01-130500	

6013 — W1

CATALOG SECTION

	ELECTRODE TYPE	ELECTRODE MATERIAL	OLD PART NO.
W1	E-1P With Shield	Brass	13-020600
W2	E-1P With Shield	303 Stainless	13-020700
W3	E-1P Less Shield	Brass	13-052700
W4	E-1P Less Shield	303 Stainless	13-052600
W5	E-1S With Shield	Brass	13-022000
W6	E-1S With Shield	303 Stainless	13-024300

These electrodes are field assembled and the required amount of Type SW wire must be ordered as a separate item. See above.

NOTE — When wire suspension electrodes are to be used with electrode plugs, or Type E or Type AE-2 electrode holders, wire connectors must also be ordered for each electrode. See above.

6013 — W7 — 10

CATALOG SECTION

	ELECTRODE TYPE	ELECTRODE MATERIAL	OLD PART NO.
W7	13-064700 With SW Wire	316 Stainless	13-064702
W8	13-064700 With SW Wire	Monel	13-064703
W9	13-064700 With SW Wire	Nickel	13-064704
W10	13-064700 With SW Wire	Carpenter 20	13-064705
W11	13-064700 With SW Wire	Hastelloy B	13-064707
W12	13-064700 With SW Wire	Hastelloy C	13-064706
W13	13-064700 With SW Wire	Titanium	13-064709

	Type SW Wire Length In Feet

These electrodes come complete with the Type SW wire permanently attached to the electrode. Lengths must be specified when ordering.

ELECTRODE MATERIAL SELECTION

The chart below suggests electrode material for some typical liquids. Electrode corrosion is difficult to predict because the rate of corrosion is effected by many factors such as: concentration, temperature and impurities. Therefore, this information should be used as a general guide, and the final choice should be determined from actual application conditions based on previous experience and knowledge.

ELECTRODE MATERIAL	TYPICAL LIQUID TO BE CONTROLLED
Brass	Soft Water, Condensate
316 SS	Water, Sewage, Beer, Alcohol, Food Products, Chemicals, Many Mild Acids
Monel	Acetic Acid, Sea Water
Nickel	Boric Acid, Calcium Hydroxide
Carpenter 20	Sulphuric Acid, Alum Solutions
Hastelloy B	Hydrochloric Acid
Hastelloy C	Hydrofluoric Acid
Titanium	Phosphoric Acid, Brine Ferric Chloride, Hot Nitric Acid
Carbon Tip	Hydrochloric Acid Carbonated Water

Contact Factory for specific recommendations.

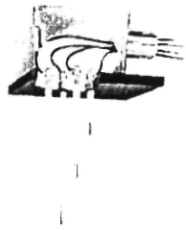
SOLID ROD ELECTRODES

6012E4 HOLDER

6013 ELECTRODE PLUG

AE-2 HOLDER

6012-CE2 HOLDER TYPE B RODS



6012-FR-56 HOLDER TYPE D RODS

TYPE A RODS

Solid rod electrodes are generally used where relatively short lengths of 6 feet or less are required. Care should be exercised when specifying lengths over 6 feet. Longer rods and those installed horizontally should be insulated. After cutting insulated rods, strip about 1 inch of insulation off lower end to expose the bare rod.

TYPE A electrode rods are ¼" diameter and have ¼-20 thread for use with electrode plugs, and Type E and Type AE-2 electrode holders. A boot made of the sheath material is furnished to protect and insulate the lower side of the electrode plug.

TYPE B electrode rods are ¼" diameter and are tapped 6-32 for use only on Type CE-2 and CE-3 holders. Lengths over 12 inch should be insulated and lengths over 30 inch not recommended.

TYPE C electrode rods are ¼" diameter and have the upper end machined with a shoulder and 10-24 thread to assemble into Type KF holders.

TYPE D electrode rods are ¼" diameter are similar to Type C except the upper end is machined to a length that fits only Type FR holders.

6013 — SS — P — A — 4

CATALOG SECTION

INSULATION MATERIAL	
X	Bare Rod
P	PVC Sheath Max. Temp. 190°F (88°C)
T	Teflon Sheath Max. Temp. 550°F (288°C)
PC	Carbon Tip Installed On PVC Insulated Rod
TC	On Teflon Insulated Rod

ROD MATERIAL	
BR	Brass
SS	316 Stainless
MO	Monel
NI	Nickel
CA	Carpenter 20
HB	Hastelloy B
HC	Hastelloy C
TI	Titanium

ROD TYPE & LENGTH

	Rod Length In Feet See Note Below
A	Has ¼-20 thread for use on Type E or AE-2 holders and electrode plugs.
6B	Has 6-32 tap for use on Type CE-2 & CE-3 holders.
8B	Has 8-32 tap for use on gland electrode assemblies.
C	Rod machined for attaching to Type KF holders.
D	Rod machined for attaching to Type FR holders.

NOTE: Standard stock rods are furnished in even foot increments up to 10 ft. long, and must be field cut for intermediate operating lengths. Contact Factory for pricing on other lengths and materials.